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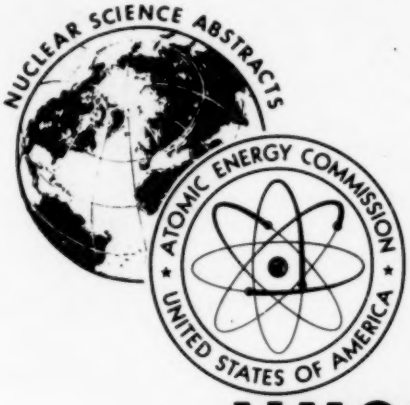

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NUCLEAR SCIENCE ABSTRACTS

Volume 19 Number 9

Abstracts 14932–17443

May 15, 1965

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The new style corporate authors appear in this issue of *Nuclear Science Abstracts* (Vol. 19, No. 9) in the citation portion of the abstract and in the corporate author index. A complete revision of corporates is infeasible at this time owing to the requirements of consolidating approved corporates with other cooperating agencies and because of the details involving cross referencing. Therefore, a new revision of TID-5059, *Corporate Author Entries Used by the Division of Technical Information in Cataloging Reports*, can be issued only after these complexities are resolved.

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3. The report series number assigned by the originator indicates a lower level of editorial responsibility.

"d. When an organization changes its name, both old and new forms of the name are retained on the list."

Volume 19, Number 9, May 15, 1965

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

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ACKNOWLEDGMENTS

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, May 20, 1963.

Volume 19, Number 9 May 15, 1965

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstracts 15004 and 15958.

14932 (ACRH-22) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION, SEPTEMBER 1964. Leon O. Jacobson, ed. (Argonne Cancer Research Hospital, Chicago, Ill.). Contract AT(11-1)-69. 168p. Dep.; $5.00(cy), 3(mn) CFSTI.

Separate abstracts were prepared for twelve sections of this report. Four sections were previously abstracted and appeared in NSA Vol. 18 as numbers 13820, 19814, 19835, and 20416. (C.H.)

For abstracts of individual sections see: 14938, 14940, 14941, 14943, 14952, 14976, 14977, 14984, 14985, 14986, 15002, and 15150.

14933 (CONF-641002(p.95-8)) EXAMINATION OF GAMMA-IRRADIATED GULF SHRIMP FOR CLOSTRIDIUM BOTULINUM AND TYPE E TOXIN. Robert M. Grodner (Louisiana State Univ., Baton Rouge. Dept. of Food and Science and Technology).

Shrimp obtained from commercial processing and packing plants in the Gulf of Mexico were negative when tested for Clostridium botulinum. (C.H.)

14934 (NYO-1800-2) ATTEMPTS TO DELINEATE INBORN ANEMIAS IN MICE. Progress Report, February 1, 1964–January 31, 1965. Elizabeth S. Russell and Seldon E. Bernstein (Roscoe B. Jackson Memorial Lab., Bar Harbor, Maine). Feb. 11, 1965. Contract AT(30-1)-1800. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Eleven different mutant genes are recognized as a cause of anemias in the house mouse. Six possible sites for action of genes affecting the erythroid homoestatic cycle in mice are described. Results are reported from analyses of various mouse anemias for genetic factors and physiological processes involved in anemia. A list is included of publications during the period covered by this report. (C.H.)

14935 (UR-659) A DILUENT FOR USE IN SIZING DOG ERYTHROCYTES. G. F. Orthey and M. Ingram (Rochester Univ., N. Y. Atomic Energy Project). Oct. 22, 1964. Contract W-7401-eng-49. 10p. Dep.; $1.00(cy), 1(mn) CFSTI

The preparation of a diluent for use with the Coulter Counter model B with size distribution plotter for sizing dog erythrocytes is described. (C.H.)

14936 (OTS-64-11410/4) ARCHIVES OF IMMUNOLOGY AND EXPERIMENTAL THERAPY. Translated Reprint of Archivum Immunologiae et Therapiae Experimentalis, 12: No. 4, 1964. 138p. $1.25(CFSTI).

A separate abstract was prepared for one article. Other articles report results of biochemical and genetic studies. (C.H.)

For an abstract of individual paper see: 15024.

14937 POTENTIATION OF MUSCULAR CONTRACTION. Alexander Sandow (Inst. for Muscle Disease, New York). Arch. Phys. Med. Rehabil., 45: 62-81(Feb. 1964).

Potentiation of contraction, especially as produced in frog skeletal muscle by chemical potentiators, is considered. Potentiation in mammalian skeletal muscle under the action of various agents such as quinine, potassium, adrenaline, caffeine, and nitrate, was found in general to be like that in frog muscle. The anions, however, at least when acting on normal rabbit skeletal muscle, cause veratrinic as well as potentiated responses. Results indicate that potentiator effects characteristic of frog skeletal muscle do not necessarily hold for other kinds of muscle and the absence of potentiation in cardiac muscle due to chemical substances studied so far may be significant in accounting for other distinctions between heart and skeletal muscle. Some anions, especially nitrate, cause potentiation by increasing the excitation-contraction coupling flux of Ca^{2+} from membrane sites into the myoplasm so as to augment activation of the contractile component and thus prolong the active state. It is not known whether a similar intensification of this Ca-link is involved in potentiation by other chemicals. Topochemical considerations indicate that the primary action of the heavy metal ions is a binding to a reactive ligand of some macromolecule, presumably at a surface site, with the respective binding constants varying in order $UO_2^{2+} > Zn^{2+} > Cd^{2+}$. In contrast to the lyotropic anions, such as nitrate, the heavy metal cations Zn^{2+}, Cd^{2+}, and UO_2^{2+} do not have any effect on the mechanical threshold, but they greatly prolong the falling phases of the action potential. Furthermore, caffeine and quinine, which seem to cause only moderate prolongation of the action potential, reduce the mechanical threshold to about the same degree as nitrate. Thus, at least three main types of potentiators exist that are distinguishable in terms of electromechanical features. Type A, represented by nitrate and other lyotropic anions, involves essentially only a lowering of the mechanical threshold. Type B includes the heavy metal potentiators, such as UO_2^{2+}, and these act only by extending the duration of the action potential. Finally, Type C potentiators, notably caffeine and quinine, act by a combination of the effects of the other two types. (BBB)

14938 BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. II. THE ANTICOAGULANT PROPERTIES OF POLYNUCLEOTIDES. S. Yachnin (Argonne Cancer Research Hospital, Chicago). Blood, 24: 553-?(1964). (ACRH-22(p.82-97))

Data are presented on the base composition of RNA and DNA from a variety of biological sources and of synthetic polyribonucleotides. Results are reported from a number of tests on the effects of base composition and secondary structure on the anticoagulant properties of the polynucleotides using blood from healthy donors and commercial preparations of coagulation reagents. The data indicate that certain polynucleotides possess anticoagulant properties that are dependent on base composition and secondary structure. (C.H.)

14939 MEIOTIC BEHAVIOR OF TANDEM METACENTRIC COMPOUND X CHROMOSOMES IN DROSOPHILA MELANOGASTER. D. L. Lindsley and L. Sandler (Oak Ridge National Lab., Tenn. and Univ. of Washington, Seattle). Genetics, 51: 223-45(Feb. 1965).

Well marked tandem metacentric compound X chromosomes of two structural types were synthesized, and their behavior in crosses was investigated. In addition to the data from these newly synthesized tandem metacentrics, previously published data on other tandem metacentrics were considered. The following conclusions emerge from an analysis of tandem metacentric data. The data do not fit the hypothesis that nullo-X eggs (detected as exceptional patroclinous males) result from the exclusion of double second-anaphase bridges from the egg nucleus; such bridges, therefore, probably result in inviable zygotes. The data are compatible with the hypothesis that nullo-X eggs arise through the loss of a fraction of the newly generated single-ring X chromosomes and that ring loss is lower in the progeny of tandem metacentric X-bearing females that carry a marked Y-chromosome fragment than of those that carry none. The exchange distribution in tandem metacentrics, as in other tandem compounds, is comparable with that of free X chromosomes, and the coefficient of nonrandomness approximates unity. (auth)

14940 BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. IV. STUDIES ON THE MECHANISM OF COMPLEMENT INHIBITION BY POLYINOSINIC ACID TOGETHER WITH OBSERVATIONS ON THE IN VIVO EFFECT OF POLYINOSINIC ACID ON COMPLEMENT ACTIVITY. A. Yachnin and D. Rosenblum (Argonne Cancer Research Hospital, Chicago). J. Clin. Invest., 43: 1175-?(1964). (ACRH-22(p.101-13))

Results are reported from studies on the mechanism of complement inhibition by synthetic polyinosinic acid in vitro. Experiments in rats demonstrated that polyinosinic acid can serve as an efficient decomplementing agent in vivo without any overt toxic effects in the animals. (C.H.)

14941 BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. III. THE ANTICOMPLEMENTARY PROPERTIES OF POLYRIBOGUANYLIC ACID. S. Yachnin (Argonne Cancer Research Hospital, Chicago). J. Immunol., 93: 155-?(1964). (ACRH-22(p.98-100))

Results are reported from studies of the anticomplementary properties of synthetic polyriboguanylic acid using guinea pig serum as a source of complement and sensitized sheep cells. The effects of base composition on the anticomplementary properties of polynucleotides are discussed. (C.H.)

14942 ON THE SPONTANEOUS ACTIVITIES OF OYSTER MYOCARDIUM CAUSED BY SEVERAL INORGANIC IONS IN SUCROSE SOLUTION. Hiroshi Irisawa and Makoto Kobayashi (Hiroshima Univ.). Japan. J. Physiol., 14: 165-76(Apr. 15, 1964).

Action potentials of oyster myocardium recorded with suction electrodes showed a similar pattern to that obtained by the intracellular microelectodes and their patterns were comparable to the action potentials of the vertebrate smooth muscles. When sea water was replaced by the isotonic sucrose solution, the spontaneous activities eventually ceased, but were restored when the heart was returned to sea water. The activities were also restored when the sucrose solution contained either Na^+, K^+, Sr^{2+}, or Ba^{2+}. It was suggested that the ionic mechanisms responsible for the initiation of action potential may not be very specific in oyster myocardium, although Na^+ may play a major role under normal conditions. (TCO)

14943 HEMOLYTIC EFFECTS OF STEROIDS. R. H. Palmer (Argonne Cancer Research Hospital, Chicago). Nature, 201: 1134-?(1964). (ACRH-22(p.62-4))

A number of neutral and acidic steroids produce fever and inflammation in man. Inflammation probably reflects the cytotoxicity of these compounds, and since hemolysis is one expression of cellular toxicity, several neutral and acidic steroids were investigated for hemolytic properties in vitro. Steroids were dissolved in 0.5 ml methanol and added to 2.0 ml 0.02 M phosphate buffered saline (pH 6.6); 0.05 ml of a 50 per cent suspension of washed human erythrocytes were then added and gently mixed. After incubation at 37.0°C, the suspensions were centrifuged and the hemoglobin in an aliquot of supernatant determined by conversion to cyanmethemoglobin with Drabkins reagent and measurement of the optical density at 540 mμ. Because the absolute rate of hemolysis varied widely with small (0.5 to 1.0°C) changes in temperature, incubations were performed with several concentrations of each steroid for a given time and with one concentration of each steroid for different periods of time. The resulting hemolytic curves permitted accurate assessment of the relative hemolytic potency of these compounds when appropriate sections of the curves were compared. The steroids tested included glycolithocholic acid, taurolithocholic acid, lithocholic acid, deoxycholic acid, chenodeoxycholic acid, progesterone, 11-ketopregnanolone, testosterone, and cholic acid. (C.H.)

14944 GENETIC DAMAGE INDUCED BY ETHYLENIMINE. Mary L. Alexander and Evalea Glanges (Univ. of Texas, Austin). Proc. Natl. Acad. Sci. U. S., 53: 282-8 (Feb. 1965).

One-day-old males of D. melanogaster were injected with a 10^{-2} M solution of ethylenimine. Ethylenimine is a powerful mutagen, but differs from both x rays and other well-known chemical mutagens in some characteristics. It resembles x rays in producing chromosomal abnormalities since translocations are nearly as frequent as sex-linked lethals. Other chemical mutagens do not produce such a high proportion of rearrangements. It resembles chemical mutagens, such as the mustards, in producing delayed lethals and translocations which appear in the F_2 generation from F_1's that appeared normal. The distribution of sex-linked lethals in the spermatogenic cycle is like that of x rays. The distribution of F_2 or delayed lethals is different. A majority was recovered from progeny of germ cells which were most nearly mature (mature sperm, late spermatids). In contrast to the delayed mutations and to direct mutations produced by other agents, the frequency of autosomal (second chromosome) lethals was very high for all stages of germ cells. The rate averaged 19.75% for all stages (A–E, sperm to spermatogonia) as compared to 0.86% for sex-linked lethals obtained in the same irradiation test from the same irradiated parents. This major difference exists despite the fact that the autosome is only about twice as long with approximately twice the number of gene loci as the X chromosome. This demonstrates that mutation production may be grossly miscalculated if based only on the sex-linked mutations detected. The same treated males show three mutation cycles— depending upon whether one tests sex-linked recessive lethals, autosomal recessive lethals, or delayed sex-linked recessive lethals. The appearance of delayed translocations restricts the way such delayed mutations occur. (auth)

14945 STAINING PROPERTIES OF LANTHANUM ON CELL MEMBRANES. C. F. Doggenweiler and S. Frenk (Harvard Univ., Boston and Massachusetts Inst. of Tech., Cambridge). Proc. Natl. Acad. Sci. U. S., 53: 425-30 (Feb. 1965).

The introduction of La^{3+} either prior to fixation (incubation in $La(NO_3)_3$) or during fixation by using a $La(MnO_4)_3$ results in unusual tagging of several structures, both intra- and extracellular. In particular, a surprising degree of density is produced in the intercellular substance in the nervous systems of vertebrates and invertebrates. The method used is described. (P.C.H.)

14946 NUCLEAR VOLUME CHANGES IN SOUTHEASTERN TREE SPECIES BEFORE SPRING GROWTH. Fred G. Taylor, Jr. (Oak Ridge National Lab., Tenn.). Radiation Botany, 5: 61-6(Mar. 1965). (ORNL-P-337)

The nuclear volume of shoot apex cells of most of 14 local tree species at Oak Ridge, Tennessee, increased before spring growth. Between January and March Pinus strobus and P. taeda showed the greatest increase in nuclear volumes from $631\mu^3 \pm 38.49$ SE to $1113\mu^3 \pm 43.12$ and from $638\mu^3 \pm 26.67$ to $1026\mu^3 \pm 23.41$ respectively. The nuclei of

Cornus florida showed no response to approach of spring activity, remaining unchanged from 99μ^3 ± 2.85 to 100μ^3 ± 5.79, while four species of Acer showed increases (45–199μ^3 in January to 83–264μ^3 in March). (auth)

14947 CARBON-14. A COMPREHENSIVE ANNUAL BIBLIOGRAPHY OF APPLICATIONS IN CHEMISTRY, BIOLOGY AND MEDICINE. VOLUME 2. Jan.-Dec. 1963. R. S. Scharffenberg and John K. Pollard, Jr. Los Angeles, Calbiochem, 1964. 126p. $7.00.

References (2956) are given to U. S. and foreign publications on carbon-14 tracer techniques in biology, chemistry, and medicine, published from 1962 through 1963. An index of carbon-14-labeled compounds is included. A list of ^{14}C, deuterium, ^{35}S, tritium, and ^{15}N-labeled compounds available through Calbiochem is also included. (P.C.H.)

Ecology

Refer also to abstract 15757.

14948 (NYO-3145-1) ZOOPLANKTON DISTRIBUTION AND ISOTOPE TURNOVER DURING OPERATION SWORDFISH. Edward J. Kuenzler (Woods Hole Oceanographic Institution, Mass.). Feb. 1965. Contract AT(30-1)-3145. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An evaluation was made of the importance of marine zooplankton in elemental cycling and transport of elements through the thermocline. Zooplankton density was measured in the eastern Pacific Ocean. Some measurement of elemental elimination rates was made using zooplankton labeled by fallout from a nuclear test; other measurements used animals tagged with tracer ^{131}I or ^{58}Co. It was concluded that turnover time for cobalt in the upper 100 m of the sea is not more than 100 years based on cobalt flux rates in zooplankton alone. (43 references) (C.H.)

14949 (TID-21544) DETERMINATION OF THE EXTENT OF ROOT DISTRIBUTION BY THE USE OF RADIOTRACER TECHNIQUES. Final Report. (Duke Univ., Durham, N. C. School of Forestry). Jan. 1, 1965. Contract AT(40-1)-2790. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A method is described for the determination of root distribution in forest stands using ^{131}I as a tracer and scintillation probes designed for field use. Applications of the method in studies of root extension in a natural stand of longleaf pine and turkey oak, root extension in a longleaf pine plantation, and root extension in mixed Piedmont hardwoods are described. Data are included from studies of ^{131}I retention by soil, the effects of ^{131}I on soil sterilization, and mineral transfer through root grafts. (C.H.)

14950 (TID-21545) A STUDY OF ROOT DISTRIBUTION IN TWO HARDWOOD STANDS IN THE DUKE FOREST. Final Report. (Duke Univ., Durham, N. C. School of Forestry). Jan. 31, 1965. Contract AT(40-1)-2790. 116p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Applications of tracer techniques, using ^{131}I, in studies of root distribution in two hardwood forests are described. After application of ^{131}I to the soil, the spot was shielded with Pb and the surrounding trees were monitored with a portable scintillation probe and scaler for 3 to 5 weeks to detect the presence of ^{131}I in the stems of trees. Oaks (Quercus sp.) and hickories (Carva sp.) were the most numerous trees in the stand, although dogwood (Cornus florida), sourwood (Oxydendrum arboreum), and red cedar (Juniperus virginiana) were also abundant. Iodine-131 was usually detected in stems within 3 days after application. Maximum distance of recorded uptake ranged from 31.8 feet for dogwood to 54.6 feet for hickory. A regression analysis using distance of trees absorbing ^{131}I from points of application as the dependent variable showed that the number of trees, tree height, and tree diameter were related to the distance of root extension. Discriminate analyses were used to determine the value of various tree characteristics for discriminating between trees that absorbed ^{131}I and those that did not. (C.H.)

14951 FIRST YEAR OF MOVEMENT, DISTRIBUTION AND AVAILABILITY OF Cs^{137} IN THE FOREST FLOOR UNDER TAGGED TULIP POPLARS. M. Witkamp and M. L. Frank (Oak Ridge National Lab., Tenn.). Radiation Botany, 4: 485-95(Dec. 1964).

Influx, distribution, and leachability of ^{137}Cs in the forest floor were measured for environmental description. Rain, leachates, litter, soil and roots were collected under the crowns of tulip poplars (Liriodendron tulipifera L.) tagged in May. The ^{137}Cs content of the samples was measured by scintillation counting. Before leaf fall 85 per cent of the ^{137}Cs in the forest floor was found in roots which consequently set the distribution pattern. Concentrations of ^{137}Cs in soil varied by 2 orders of magnitude within a few cm distance. Distribution of ^{137}Cs was less influenced by rainout and runoff. Ten soil cores of 7 cm^3, 2.1 cm diameter and 2 cm deep, were found sufficiently large to estimate local mean distribution of ^{137}Cs in litter and in soil, in the various seasons. Variabilities (s as percentage of X) ranged from 31–62% of the mean. Leaf fall doubled the total amount of ^{137}Cs in the forest floor and increased the amount of ^{137}Cs in litter 15 fold. Leachability of ^{137}Cs in the fresh litter was nine times greater than in old litter and increased the content of mobile ^{137}Cs in the entire litter layer by two orders of magnitude. During winter more than half of the ^{137}Cs in litter and roots leached into the soil. In spring there was renewed rainout from the canopy. The large differences in amount, concentration, and leachability of ^{137}Cs over short periods of time and distances could only be measured by combining the results of detailed and frequent sampling using a variety of methods. (auth)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 15659 and 15660.

14952 (ACRH-22(p.48-52)) THE ERYTHROPOIETIC EFFECT OF TESTOSTERONE IN THE POLYCYTHEMIC MOUSE. W. Fried, R. De Gowin, and C. W. Gurney (Argonne Cancer Research Hospital, Chicago).

To be published in Proc. Exptl. Biol. Med.

The effects of testosterone on the rate of ^{59}Fe metabolism in polycythemic mice were studied. Results indicated that testosterone, when given in pharmacological doses, caused a significant increase in the rate of erythropoiesis in the mice. It was concluded that testosterone affects differentiation of stem cells into the erythroid series. Possible reaction mechanisms are discussed. (C.H.)

14953 (BNL-7859) IMPROVED STRONTIUM AUTORADIOGRAPHY OF MINERALIZED TISSUES WITH INTERNAL CONVERSION AND AUGER ELECTRON EMITTING Sr^{85}. Leon Pentel and Edgar A. Tonna (Murry and Leonie Guggenheim Foundation Inst. for Dental Research, New York Univ., N. Y. and Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 10p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Strontium-85 produced satisfactory autoradiograms to determine the deposition, localization, and distribution of Sr in the bones and teeth of pre-natal mice. Procedures are described. (C.H.)

14954 (BNL-7917) ON THE DISTRIBUTION OF REDUCED SILVER GRAINS IN AUTORADIOGRAMS OF BONE AND CARTILAGE FOLLOWING H^3-AMINO ACID ADMINISTRATION. Edgar A. Tonna (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An analysis was made to evaluate the possible significance of the collagen/mucopolysaccharide protein ratio on the autoradiographic grain counting data of bone and cartilage following ^3H-amino acid administration. Over bone the number of grains attributed to MPC was about 1% for glycine, histidine, proline and lysine. While over cartilage 5%, 33%, 8%, and 17% of the grains were attributed to MPC for

the respective amino acids. Analyses were based on the C/MPC ratio available from different animal sources and the specific amino acid composition of C and MPC. The possibility of variations in results due to animal age, differences in similar tissues taken from different animal species or samples removed from different sites within the same animal were also discussed. (auth)

14955 (CEA-R-2585) CONTRIBUTION A L'ETUDE DES PROPRIETES BIOLOGIQUES DES COMPOSES MARQUES AU RADIOCHROME ^{51}Cr. (Contribution to the Study of the Biological Properties of Compounds Labeled with Radio-Chromium ^{51}Cr). Jacques Ingrand (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 116p. Dep.(mn).

Thesis submitted to Université, Paris.

Applications of ^{51}Cr incorporated in inorganic salts or organic substances in biological studies are reviewed. Data are presented on the Cr content in human organs and tissues. The preparation, properties, and toxicity of $^{51}CrCl_3$ and $Na_2{}^{51}CrO_4$ are discussed and results are reported from studies of the metabolism of these compounds in laboratory animals. The influence of various factors on the fixation of ^{51}Cr by hematopoietic tissues and blood cells in vitro is discussed. The preparation and use of ^{51}Cr-labeled erythrocytes, hemoglobin, plasma proteins, and cytochrome C in biological studies are reviewed. (188 references) (C.H.)

14956 (NYO-901-3) THE FORMS OF TRYPTOPHAN PYRROLASE IN LIVER. W. Eugene Knox (New England Deaconess Hospital Boston, Mass. Cancer Research Inst. and Harvard Univ., Boston, Mass. Medical School). Mar. 1, 1965. Contract AT(30-1)-901. 16p. (CONF-641019-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Japanese Biochemical Society Meeting, Nagoya, Japan.

The first step in tryptophan oxidation in animals is regulated by changes in the concentration of the responsible enzyme, tryptophan pyrrolase. Measurements of these changes in amount of enzyme is based on changes in activity demonstrable in vitro, confirmed by immunochemical measurements. In the activity measurements two known inactive forms of the enzyme are converted to the active form: a process requiring conjugation of the apoenzyme with the hematin prosthetic group and reduction to the active ferroporphyrin form of the enzyme. The persistence of the lag period of the reaction may indicate that there is still another precursor of the active enzyme species. Any theory about the mechanisms of the substrate and hormonal inductions of this enzyme must take into account the changing concentrations of these different forms of tryptophan pyrrolase during induction. (auth)

14957 (ORNL-3703) MICROSCOPIC AND AUTORADIOGRAPHIC STUDIES OF DISTRIBUTION OF URANIUM IN THE RAT KIDNEY. Edith Seymour Jones (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 65p. Dep.; $3.00(cy), 2(mn) CFSTI.

The distribution of uranium in rat kidney was studied by autoradiography and the data compared with that found by radiochemical analysis in order to obtain more information relating to the phenomenon of prolonged retention of uranium by kidneys of rats given an intravenous injection of a large mass of uranium. Dose levels of 10 μg U/kg, 100 μg U/kg, and 1000 μg U/kg were used. These experiments indicate that retention is significantly higher at the two higher dosage levels than at the lowest level. A concentration ratio, the ratio of the average concentration in the cortex to the average concentration in the entire kidney, was approximately 1.3. At early times postinjection the uranium tracks were observed mainly in proximal tubules, but an increasing proportion of total tracks was in distal tubules as postinjection time increased. Leaching and redistribution of uranium, in the processes of preparation, appeared to be negligible. There were indications of a gradient in the cortex when aggregates were counted, but with aggregates excluded the concentrations were similar throughout the cortex. Proximal tubules of damaged kidneys did not show a change in diameter from those of normal kidneys, but glomeruli in injected rats tended to be smaller than in uninjected rats. Histopathological changes up to 28 days postinjection were striking at high dose levels. (auth)

14958 EFFECT OF LARGE DOSES OF RADIOIODINE ON THYROID FUNCTION. I. AUTORADIOGRAPHIC LOCALIZATION OF ORGANIC IODINE IN THE THYROID GLAND. M. Jovanovic, Dj. Djurdjevic, and J. Sinadinovic (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine and Forestry, Zemun, Yugoslavia). Acta Endocrinol., 6: 1-8(Jan. 1965).

The effects of relatively high doses of ^{131}I (150 μC/100 g body weight) were observed on the percentage deposition of ^{131}I in the thyroid glands of rats, and on the pattern of histological localization as shown by autoradiograms. At 24 hours after dosage, there was no interference in the capability of the gland to concentrate iodine and to convert it to the organic form. However, there was a marked inhibition of the transfer of thyroglobulin from the cells to the colloid as shown by the autoradiograms. The possible use of this behavior as a method for study of the mechanism of hormone synthesis is illustrated. (auth)

14959 A COMPARATIVE STUDY OF IODINE METABOLISM IN PREGNANCY, SPORADIC GOITRE AND THYROTOXICOSIS. S. A. Aboul-Khair and J. Crooks (Univ. of Aberdeen, Scotland). Acta Endocrinol., 6: 14-22(Jan. 1965).

Studies of iodine metabolism were carried out in 15 pregnant women, 33 cases with sporadic goiter and 11 with thyrotoxicosis. A low plasma inorganic iodine was common to the three groups. In pregnancy and sporadic goiter the thyroid clearance of iodine was elevated and the absolute iodine uptake normal. A high thyroid clearance of iodine in thyrotoxicosis was associated with a high absolute iodine uptake. The results suggest that both pregnancy and sporadic goiter are physiological responses to an iodine deficiency state while the iodine deficiency state of thyrotoxicosis is secondary to increased thyroid activity. (auth)

14960 STUDIES ON THE DISTRIBUTION OF RADIOISOTOPES USED FOR BRAIN TUMOR DIAGNOSIS IN THE BLOOD STREAM, IN EXPERIMENTAL TUMORS, AND IN HUMAN BRAIN TUMORS. F. Mundinger and H. Gerhard (Universitat, Freiburg i.B.). Acta Neurochir., 11: 398-415 (Nov. 21, 1963). (In German)

Experimental and clinical data are reported on the distribution of ^{74}As, ^{203}Hg-Neohydrin, as well as ^{64}Cu, ^{206}Bi, and ^{131}I in various compounds. Special attention was given to the selective concentration of these diagnostic isotopes in brain tumors. With density-gradient electrophoresis and protein precipitation it was found that α-β-globulins are the carrier proteins for the circulation of ^{206}Bi, and albumin for the circulation of ^{203}Hg-Neohydrin. The ^{74}As in rat blood had a high affinity for erythrocytes, and a negligible tendency to combine with the serum proteins. With mouse tumor an investigation was made on the distribution of ^{206}Bi and ^{203}Hg-Neohydrin in the tumor cells by fractional centrifugation. The main portion (30–50%) of ^{206}Bi and ^{203}Hg-Neohydrin is bound to the cytoplasmic proteins of the tumor cells. The ^{206}Bi concentration (25 to 40%) in the tumor cell nuclei exceeded that of the mitochondria (15 to 25%). Similar distribution percentages were found with ^{203}Hg-Neohydrin. In a study of ^{206}Bi dispersion in human meningiomata, 50% of the Bi was in the cytoplasm with a smaller uptake in the formed cell structures. In glioblastoma cells the ^{206}Bi concentration of the mitochondria (25%) exceeded that of the cell nuclei (20%). By contrast, in astrocytomata the cell nuclei possess more activity (40%) than the mitochondria (20%). After incubation of Ehrlich, Yoshida, and DS ascites tumor cells it was found that ^{74}As, ^{131}I-polyvinylpyrrolidone, and ^{131}I-Hippuran are not capable of entering into the tumor cells. ^{131}I, which is presumably bound loosely to the cell membrane in very small quantities, and ^{131}I-albumin, which is only taken into the cell in small amounts (1 to 3%), also remain extracellular. In contrast, ^{64}Cu and its EDTA and DTPA complexes were taken into the tumor cells in high concentrations (50 to 60% of the initial activity). ^{206}Bi as nitrate, citrate, and EDTA complex forms was found to be 30 to 50% intracellular, but ^{206}Bi-DTPA remained extracellular. ^{203}Hg-

Neohydrin was taken up within the cancer cells in very small quantities; ^{206}Bi and ^{64}Cu were concentrated by ascites tumor cells 100-fold in comparison with the surrounding medium. However, the tumor cells also contain small quantities of ^{74}As, ^{131}I, and ^{131}I-albumin, indicating that distribution of these isotopes is by diffusion. (TCO)

14961 INCORPORATION OF Fe^{59} IN HUMAN BONE MARROW CELLS IN VITRO UNDER CONDITIONS OF ALTITUDE HYPOXIA. Andrzej Polubiec (Instytutu Hematologi, Warsaw). Acta Physiol. Polon., 15: 803-17(1964). (In Polish)

Human bone marrow cells with added ^{59}Fe were incubated in a small low pressure chamber. Controls were incubated under conditions of normal atmospheric pressure. It was found that altitude hypoxia stimulates human bone marrow cells in vitro to increased incorporation of labeled iron. Under conditions of altitude hypoxia incorporation of iron is increased by about 58%. (auth)

14962 EFFECT OF DIETARY ZINC ON METABOLISM OF ZINC 65 IN HENS. E. W. Kienholz, M. L. Sunde, and W. G. Hoekstra (Univ. of Wisconsin, Madison). Am. J. Physiol., 208: 347-52(Feb. 1965).

Hens fed zinc-deficient (10 ppm Zn) and zinc-supplemented (70 ppm) diets for 5 months were given zinc-65 intramuscularly, and fecal and egg radioactivity was followed for 70 days before the hens were sacrificed. Egg yolks accounted for nearly all of the total egg radioactivity. The low-zinc diet reduced fecal isotope loss to 60% of that observed for the high-zinc diet. Fecal and egg-yolk excretion patterns of zinc-65 suggested that the pool of rapidly turning-over zinc, which is the precursor for egg and fecal zinc was smaller and had a shorter turnover time in the zinc-deficient hens. However, the size of the total body zinc pool was little affected by diet. At 70 days after injection, zinc-deficient hens had about 30% as much radioactivity per unit of bone but about 150% as much radioactivity per unit of soft tissue as did the zinc-supplemented hens. These differences in zinc-65 distribution were of the same magnitude when expressed as counts per minute per milligram zinc. (auth)

14963 BRONCHIOLO-ALVEOLAR TUMORS OF THE CANINE LUNG FOLLOWING INHALATION OF PLUTONIUM PARTICLES. William J. Clarke, James F. Park, James L. Palotay, and William J. Bair (General Electric Co., Richland, Wash.). Am. Rev. Respirat. Diseases, 90: 963-7(Dec. 1964). (HW-SA-3445)

Inhalation of plutonium particles caused spontaneous deaths at 55 to 1,446 days after exposure in beagle dogs having a lung burden of 0.6 to 48 μC of $^{239}PuO_2$. Four dogs surviving more than 1,150 days and one animal that died 150 days following exposure to high levels of plutonium aerosols showed bronchiolo-alveolar tumors. Although most of these neoplasms were locally invasive, and some appeared to be of multicentric origin, no evidence of regional or distal metastasis was seen. The progression sequence of tumor formation appeared to be desmoplasia, metaplasia, and, finally, neoplasia. (auth)

14964 DETERMINATION OF LIPASE ACTIVITY BY FLORISIL COLUMN CHROMATOGRAPHY AND LIQUID SCINTILLATION SPECTROMETRY. Haruo Chino and Lawrence I. Gilbert (Northwestern Univ., Evanston, Ill.). Anal. Biochem., 10: 395-400(Mar. 1965).

Pancreatic lipase activity was assayed by Florisil column chromatography and the use of ^{14}C-carboxyl-labeled triolein. This method allows the demonstration of lipase activity and determination of the concentrations of triglycerides, diglycerides, monoglycerides, and free fatty acids in the incubation medium during the course of lipolysis. (auth)

14965 ENZYMIC SYNTHESIS OF GLUCOSE-4-TRITIUM AND GLUCOSE-3-TRITIUM. Robert Rognstad, Robert G. Kemp, and Joseph Katz (Cedars-Sinai Hospitals, Los Angeles). Arch. Biochem. Biophys., 109: 372-5(Feb. 1965).

Dihydroxyacetone phosphate and D-glyceraldehyde phosphate were labeled with tritium in position 1 by enzymic exchange and isomerization in tritiated water. The labeled trioses were condensed by means of aldolase to fructose-1, 6-diphosphate labeled with tritium either in position 3 or 4. Labeled glucoses were prepared from the phosphate esters. The labeled sugars were obtained with a yield of 25% and specific activities of 5 μC per μmole. (auth)

14966 THE QUANTITATIVE MEASUREMENT OF THE UPTAKE OF DISSOLVED SUBSTANCES IN AND THROUGH THE SKIN. K. Dirnagl and H. Drexel (Universitat, Munich). Arch. Physik. Therapie, 15: 283-306(Sept.-Oct. 1963). (In German)

Two basic roles can be envisaged for the function of the skin in transfer of substances. One is that the skin has an essentially passive function as a transport medium, and the other is that it actively participates in transfer as a result of chemical effects and properties. Several factors affect skin absorption of substances contained in a bath or solution. The most important of these include the chemical properties and concentration of the substance resorbed, the size of the skin area exposed to the solution, and the time that the skin is exposed to the chemical solution. Transport of water through the skin can be measured by means of tritiated water. Studies with this and other radioactive materials indicate that the rates of transport and exchange of various ions into and out of the outermost layers of skin are extremely rapid. The loss of ions from the skin is the result of transport into the internal portions of the body as well as the result of loss by sloughing of the outer areas of the skin where the ions may be deposited. (BBB)

14967 CONCERNING THE SYNTHESIS OF RNA IN THE CHROMATIN AND THE NUCLEOUS OF THE HUMAN CANCER CELL HeLa-S_3 IN CULTURE. L. E. Feinendegen (Universite, Paris) and V. P. Bond. Atomkernenergie, 9: 283-93(1964). (In Dutch) (EUR-2147.d)

Pulse exposure of HeLa-S_3 cells to ^3H-cytidine resulted in RNA labeling (non-acid-soluble) exclusively in the cell nucleus during interphase, with various participation of the nucleolus. The comparison, in autoradiograms, of the nucleolar labeling patterns in the cell population with the labeling of the chromatin portion of the nuclei indicate the engagement of three macromolecular RNA fractions in nucleolar function: an RNA of the nucleolar margin (nucleolar associated chromatin) with a relatively rapid turnover; an RNA of the nucleolar center with a relatively rapid turnover; and an RNA of the nucleolar center with a relatively slow turnover. The observed asynchrony in the labeling of nucleolar RNA apparently does not depend solely on the stage of the cell in the generation cycle. The relation among these RNA fractions cannot be properly recognized by autoradiography alone, also due to the lack of autoradiographic registration of label bound to acid soluble nucleotides. Data are presented which point to an acid soluble nucleotide fraction to participate in the function of the nuclear and nucleolar RNA. The results do not contradict the hypothesis according to which nucleolar RNA depends on RNA of the chromatin; still, totally independent RNA synthesis in the nucleolus is not excluded. (auth)

14968 THE EFFECT OF A RADIO-PROTECTIVE DRUG (S-(2-AMINO ETHYL) THIURONIUM BROMIDE HYDROBROMIDE), UPON THE GENERAL AND CORONARY HAEMODYNAMICS AND METABOLISM OF THE INTACT DOG. G. M. Maxwell and G. M. Kneebone (Univ. of Adelaide). Australian J. Exptl. Biol. Med. Sci., 42: 601-6(Oct. 1964).

The cardiovascular effects of a radioprotective drug (S-(2-aminoethyl) thiuronium bromide hydrobromide) were investigated in intact dogs. This substance decreased cardiac output and increased systemic pressure and resistances. Coronary flow was decreased, cardiac oxygen extraction was increased, and cardiac efficiency maintained. (auth)

14969 EFFECT OF SOME RADIOMIMETIC AGENTS ON DEOXYRIBONUCLEIC ACID SYNTHESIS IN ESCHERICHIA COLI AND TRANSFORMATION BACILLUS SUBTILIS. Asaharu Terawaki and Joseph Greenberg (Palo Alto Medical Research Foundation, Calif.). Biochim. Biophys. Acta, 95: 170-3(Jan. 11, 1965).

Evidence is presented that treatment of Bacillus sub-

tilis with nitrofurazone, azaserine, proflavine, and nitrosoguanidine in vivo resulted in the inactivation of subsequently extracted transforming factor. Also, azaserine and nitrosoguanidine inactivated B. subtilis transforming factor in vitro. However, none of the agents selectively inhibited the net synthesis of DNA in E. coli. (P.C.H.)

14970 ACTIVE ACCUMULATION OF Sr^{2+} BY RAT-LIVER MITOCHONDRIA. I. GENERAL FEATURES. Ernesto Carafoli, Suella Weiland, and Albert L. Lehninger (Johns Hopkins Univ., Baltimore). Biochim. Biophys. Acta, 97: 88-98(Jan. 4, 1964).

The accumulation of large amounts of Sr^{2+} by rat liver mitochondria is described in detail. Sr^{2+} is rapidly accumulated from the suspending medium by respiring rat-liver mitochondria in an energy-linked process. The accumulation proceeds in two phases: a rapid phase, requiring only seconds, and a slow phase, requiring several minutes. Almost half the Sr^{2+} uptake occurs in the rapid phase, which requires respiration in the presence of phosphate, but not adenosine 5′-triphosphate or Mg^{2+}. The second phase requires respiration in the presence of adenosine 5′-triphosphate, inorganic phosphate, and Mg^{2+}. Maximum rates of Sr^{2+} uptake occur at a Sr^{2+} concentration of 2 mM; the maximum amount accumulated is about 2.5 μmoles Sr^{2+} per mg mitochondrial protein. Oligomycin inhibits neither phase of respiration-supported Sr^{2+} uptake; 2,4-dinitrophenol (DNP) inhibits both. Sr^{2+} uptake may also be supported by adenosine 5′-triphosphate alone, even when respiration is inhibited by CN^-; in this case two phases of Sr^{2+} uptake are also observed. However the rapid phase of adenosine 5′-triphosphate-supported Sr^{2+} uptake is not inhibited by oligomycin. Sr^{2+} uptake in both phases is accompanied by uptake of phosphate; the Sr/inorganic phosphate accumulation ratio is 1.2–1.4. The rapid phase of Sr^{2+} uptake is stimulated by K^+, the slow phase is inhibited by K^+. (auth)

14971 ACTIVE ACCUMULATION OF Sr^{2+} BY RAT-LIVER MITOCHONDRIA. II. COMPETITION BETWEEN Ca^{2+} AND Sr^{2+}. Ernesto Carafoli (Johns Hopkins Univ., Baltimore). Biochim. Biophys. Acta, 97: 99-106(Jan. 4, 1965).

The competition between Sr^{2+} and Ca^{2+} in the ion-accumulation process by rat liver mitochondria, as well as the simultaneous accumulation of both ions, in respiration-supported and ATP-supported systems is described. Ca^{2+} inhibits the respiration-linked accumulation of Sr^{2+} in a competitive manner. Both ions may be accumulated simultaneously from the medium, the relative amounts of each being determined by the competition. The inhibiting action of Ca^{2+} is primarily on the rapid phase of Sr^{2+} uptake. When the ion accumulation is supported by adenosine 5′-triphosphate instead of respiration, the inhibiting effect of Ca^{2+} on Sr^{2+} uptake is much less pronounced. The release of both Sr^{2+} and Ca^{2+} from loaded mitochondria is promoted by 2,4-dinitrophenol. (P.C.H.)

19472 ACTIVE ACCUMULATION OF Sr^{2+} BY RAT-LIVER MITOCHONDRIA. III. STIMULATION OF RESPIRATION BY Sr^{2+} AND ITS STOICHIOMETRY. Ernesto Carafoli (Johns Hopkins Univ., Baltimore). Biochim. Biophys. Acta, 97: 107-17(Jan. 4, 1965).

Addition of Sr^{2+} to rat liver mitochondria suspended in a medium of respiratory substrate, Mg^{2+}, and phosphate causes a large stimulation of respiration, the duration of which is proportional to the Sr^{2+} added. The rate of respiration then returns to the original level. During the period of respiratory stimulations Sr^{2+} is accumulated by the mitochondria; when the Sr^{2+} of the medium is exhausted, respiration returns to the original low rate. Tests with β-hydroxybutyrate and succinate show that between 1.8 and 2.0 ions of Sr^{2+} are accumulated as a pair of electrons traverses each of the three energy-coupling sites of the respiratory chain. One atom of extra oxygen was taken up during accumulation of 3.8 moles of Sr^{2+} when succinate was the substrate, and 5.6 moles of Sr^{2+} when β-hydroxybutyrate was the substrate. Succinate oxidation is stimulated to higher rates by addition of Sr^{2+} than is β-hydroxybutyrate oxidation. Accumulation of phosphate accompanies accumulation of Sr^{2+}. When phosphate is not present in the medium, Sr^{2+} also stimulates respiration, but in this case the return to the inhibited state takes place only with concentrations of Sr^{2+} lower than 400–500 μM. The respiration continues indefinitely at the stimulated rate when higher concentrations of Sr^{2+} are added. The accumulation of Sr^{2+} in the absence of phosphate is much smaller than in its presence. Phosphate is therefore not required for stimulation of oxygen uptake but only for accumulation of large amounts of Sr^{2+}; when the latter is exhausted, the oxygen uptake ceases. (auth)

14973 THE RATIO OF TOTAL PLASMA ^{131}I AND SALIVARY ^{131}I IN THYROID DISEASE. Kevork Kuyumcuyan and Ali Gorpe (Capa Hastaliklari Klinigi, Istanbul). Bull. Fac. Med. Istanbul, 27: 86-94(1964). (In Turkish)

The thyroid uptake of ^{131}I and the total saliva/plasma ratios of ^{131}I were determined in 60 patients, including 20 who were euthyroid, 20 goitrous, 12 hyperthyroid, 7 hypothyroid, and 1 with thyroid cancer. The values at 1, 2, 6, 24, 48, and 72 hr after administration of 50 to 100 mC ^{131}I by mouth were determined, but results are reported mainly for the 24-hr values. The respective saliva/plasma ^{131}I ratios for these intervals were: 29, 49, 33, 18, 2.7, and 1.29, as average values for all patients studied. The 24-hr values for the ratio varied from 16.5 to 45.4 in the euthyroid subjects. In simple goiter the average value was 13.9, and in iodine deficiency goiter 10.7. In hyperthyroidism and hypothyroidism the average 24-hr ratios were 1.29 and 53.3, respectively. These values obtained for the saliva/plasma ^{131}I ratio closely paralleled the thyroid gland uptake values, and it is suggested that this ratio can be used as a valuable auxiliary test for thyroid activity. (BBB)

14974 STUDIES ON THE BIOSYNTHESIS OF NUCLEOTIDES IN EHRLICH ASCITES CARCINOMA CELLS IN VITRO. B. I. Uppin and P. G. Scholefield (McGill-Montreal General Hospital Research Inst., Montreal). Can. J. Biochem., 43: 209-24(Feb, 1965).

Studies were made on the effects of metabolic inhibitors on the oxidation and incorporation of radioactivity into nucleotides of glucose labeled in the 1, 2, and 6 positions. The results indicate that in Ehrlich ascites carcinoma cells the predominant oxidative pathway is the hexosemonophosphate shunt. Investigation of the time courses of oxidation of the labeled glucose molecules confirmed this conclusion. The pattern of incorporation of radioactivity initially suggests that nucleotide ribose is not formed via this pathway. However, it is shown that the coupling of an active transketolase system with the other enzymes of the hexosemonophosphate shunt provides a sufficient explanation of all the experimental observations. It was concluded that pentose is formed by oxidation of glucose through the shunt but that the labeling pattern is largely established as the result of the exchange reaction catalyzed by transketolase. (auth)

14975 INHERITANCE OF Sr-89 ACCUMULATION IN WHEAT AND BARLEY. D. C. Rasmusson, L. H. Smith, and R. A. Kleese (Univ. of Minnesota, Minneapolis). Crop Sci., 4: 586-9(Nov.-Dec. 1964). (COO-1097-12)

Four barley and 4 wheat varieties and their F_1, F_2, F_3, and backcross progenies were used to study heritability of Sr-89 accumulation. The plant material was grown in the greenhouse in pots containing soil to which Sr-89 was added prior to planting. Average Sr-89 accumulation in the grain for parental, F_1, F_2, and backcross populations indicated that there is substantial genetic control of the processes involved in Sr-89 accumulation in the grain. With few exceptions, Sr-89 concentration in the grain of various populations could be accounted for by additive genetic effects. Broad sense heritability estimates ranged from 40 to 70% and 26 to 63% in wheat and barley, respectively. Heritability estimates obtained from the regression of F_3 offspring on F_2 parent plants for 1 barley and 1 wheat cross were 30.0 and 30.1%, respectively. Realized heritabilities ranged from 15 to 50% and were greater for low than for high selection. It was concluded that selection on the individual plant basis for low or high strontium concentration would be effective. (auth)

14976 IN VITRO STUDIES OF CELL TYPES RESPONSIVE TO ERYTHROPOIETIN. F. Takaku (Tokyo Univ.), P. P. Dukes, and E. Goldwasser. Endocrinology, 74: 402-? (1964). (ACRH-22(p.39-44))

The effects of anemic plasma and of several partially purified fractions of erythropoietin on the incorporation of ^{14}C-glucosamine by blood and bone marrow cells in culture were studied. The cells included normal rat bone marrow, bone marrow from starved rats containing a reduced percentage of normoblasts, hyperplastic rat bone marrow, bone marrow from rats exposed to 600 R whole-body x radiation, and spleen cells from polycythemic mice. Results indicated that erythropoietin may act on stem cells alone, may act on differentiated daughter cells of stem cells alone, may cause stem cell differentiation, and may also act on the first descendents of stem cells that have already been directed toward the red cell lineage. (C.H.)

14977 IN VITRO STUDIES ON THE EFFECT OF ERYTHROPOIETIN ON GLUCOSAMINE-1-C^{14} INCORPORATION INTO RAT BONE MARROW CELLS. P. P. Dukes (Argonne Cancer Research Hospital, Chicago), F. Takaku, and E. Goldwasser. Endocrinology, 74: 960-? (1964). (ACRH-22)p.29-38))

Erythropoietin was shown to stimulate the incorporation of ^{14}C-glucosamine into the structural material of rat bone marrow cells maintained in culture. Preliminary results of the chemical characterization of the labeled materials derived from the cells are presented. The labeled fraction of the cells resembled red cell stroma. (C.H.)

14978 THYROIDAL IODIDE ACCUMULATION AND LOSS IN VITRO. J. R. Scranton and N. S. Halmi (State Univ. of Iowa, Iowa City). Endocrinology, 76: 441-53 (Mar. 1965).

First order rate constants for $^{131}I^-$ exit from rat thyroid lobes in vitro (K_{TM}) were measured directly, using a method whereby the incubating medium was repeatedly replaced at 2-min intervals, and indirectly, by applying a 2-compartment (thyroid-medium) model to the findings from $^{131}I^-$ uptake experiments. In studies of $^{131}I^-$ exit only, K_{TM} was enhanced by increasing the concentration of I^- in either the incubating medium or the thyroid lobe, and by the presence of ClO_4^-, dinitrophenol, ouabain or excess K^+ in the medium. The increased K_{TM} diminished when excess I^-, dinitrophenol, or ouabain were removed from the bathing fluid. The effect of ouabain was largely overcome by raising the medium K^+ concentration. In $^{131}I^-$uptake studies, a high concentration of I^- or ClO_4^- in the incubating fluid depressed the unidirectional clearance of $^{131}I^-$ from the medium by the thyroid (C/m) and raised the K_{TM}, but these findings could not be considered quantitatively reliable because of limitations of the model. Large amounts of I^- in the gland lowered C/m to the same extent as they elevated K_{TM}. Dinitrophenol and ouabain, on the other hand, produced little depression of the C/m, but a marked rise in K_{TM}. Excess K^+ in the medium moderately decreased C/m and increased K_{TM}; it did not materially influence C/m when added to medium containing ouabain, but diminished K_{TM}. The effects of I^- and ClO_4^- on K_{TM} and C/m can be most easily explained by postulating that they diminish the uptake of $^{131}I^-$ by the thyroid and its recirculation with the lobe (through saturation and inhibition, respectively, of the I^- transport mechanism). Under the conditions of these experiments, dinitrophenol and ouabain, on the other hand, appeared to exert their main influence by decreasing the effectiveness of a barrier to $^{131}I^-$ egress from the follicles. Excess K^+ apparently counteracted this influence of ouabain; its effect per se may have been more complex. (auth)

14979 DISCREPANCIES IN MITOTIC CYCLE TIME WHEN MEASURED WITH TRITIATED THYMIDINE AND COLCHICINE. J. Van't Hof (Brookhaven National Lab., Upton, N. Y.). Exptl. Cell Res., 37: 292-9(Feb. 1965).

Tritiated thymidine (^{3}H-T) and colchicine were compared with respect to their use in measuring the mitotic cycle duration of root meristem cells of Pisum sativum. The mitotic cycle of Pisum root meristem cells at 20°C ± 1 was measured by labeling with ^{3}H-T(spec. act. 5.3 × 10^3 mC/mM, 2μC/ml) for 30 min and observing the sequential appearance and disappearance of labeled mitotic figures, treatment with 3.76 × 10^{-4} M colchicine for 30 min and observing the eventual appearance of tetraploid mitotic figures, and simultaneously treating the meristems with ^{3}H-T and colchicine. The latter procedure distinctly marks cells in two different segments of the mitotic cycle. Cells entering mitosis are affected by colchicine in such a manner as to prevent cytokinesis but not karyokinesis; these cells appear as tetraploids in the subsequent mitosis and thereby provide a measurement of the mitotic cycle duration. Since DNA synthesis in Pisum takes place approximately midway in interphase, ^{3}H-T labeled cells appear in mitosis before the tetraploid cells. When the ^{3}H-T labeled cells are in division, the tetraploid cells are in interphase and vice versa. Thus the combined use of ^{3}H-T and colchicine provide a quick and accurate measurement of the interphase period durations. The results indicate that the first mitotic cycle following pulse labeling with ^{3}H-T averages 1.4 times longer than that measured with colchicine, and the increase in the cycle time measured by ^{3}H-T appeared to occur in G_1. The elongated cycle as measured with ^{3}H-T was hypothesized to be either the result of chronic β-irradiation from tritium located in the cellular DNA or the result of different population constituents composing the ^{3}H-T labeled cells and the colchicine-induced tetraploid cells. (auth)

14980 HISTOCHEMICAL INVESTIGATION INTO THE TOXIC EFFECT PRODUCED BY URANIUM IN EXPERIMENTS ON RATS. I. V. Shust. Farmakol. i Toksikol., 27: 362-3(1964). (In Russian)

Four series of experiments staged on rats were devoted to the study of toxic effects produced by uranyl nitrate on the liver, kidney, spleen, and myocardium. A reduction of alkaline phosphatase was noted under the influence of the injected uranyl, along with a changed enzyme localization in the kidney. (auth)

14981 ON THE DISTRIBUTION OF ^{22}Na AND ^{131}I AFTER THE EXCLUSION OF THYROID AND RENAL FUNCTION. S. Zappacosta, G. Giuranna, and F. Pescione (Universita, Naples). Giorn. Ital. Chir., 18: 223-30(May 1962). (In Italian)

Adult Wistar rats were divided into four groups: controls; thyroidectomized; renal function blocked through bilateral ligature of the ureters; and thyroidectomized-ureteral ligature groups. Plasma radioactivity was determined in samples taken at intervals of 15, 30, 60, 120, 180, and 240 min after injection of Na^{131}I and ^{22}NaCl. Sodium space and iodide space were measured by an extrapolation method. The animals were studied 24 hr after ureteral ligature and between the 14th and 21st days after thyroidectomy. All animals were injected intravenously with 25 μC of a solution of Na^{131}I (sp act. 5 mC/mg) and 25 μC of a solution of ^{22}NaCl (sp act. 1.97 mC/mg) for each 100 g body weight. The plasma concentration curve of the normal animals showed a rapid fall of ^{131}I while ^{22}Na ion decreased more slowly. The thyroidectomized group showed a decrease of I space and increase of Na space. Hyperthyroidism caused an increase of the thyroid parenchymal tissue and thus also of the extracellular space. The plasma I concentration showed a similar value to the Na concentration. A slight increase in the Na space with the iodide space being very much enlarged was observed in the bilateral ureteral ligature group. The thyroidectomized plus ureteral ligature groups showed considerable increases in both I space and Na space. The Na ion elevation is related to the hyperthyroidism and uremia, and the I elevation to the halogen ion increases in interstitial space and the renal parenchyma. This confirms the analogous distribution of the sodium and iodide ions. The following Na and I space values were observed in the various groups: normal animals, 27.5 and 50 ml; thyroidectomized, 36 and 39 ml; bilateral ligature, 32 and 60 ml; thyroidectomized plus bilateral ureteral ligature, 38 and 79 ml. (BBB)

14982 INFLUENCE OF THE COMPOSITION OF POTASSIUM, SODIUM, AND CALCIUM ON THE ACCUMULA-

TION OF Cs^{137} IN CROPS. E. V. Yudintseva. Izv. Timiryazev, Sel'skokhoz. Akad., No. 4, 76-91(1963). (In Russian)

The influence of K, Na, and Ca units and acidity of soils on the accumulation of cesium in yield was studied on plants of wheat and peas. An increase of potassium content in plants and soil resulted in decreasing radiocesium content in the yield that meant that K may be used for decreasing the content of this element in plants. The same result may be succeeded with decreasing concentration of pH-ions in soil. Calcium and sodium carbonate and hydrates of Ca and particularly of Na oxides decreased the accumulation of radiocesium when soils were acidic and had no action when the soil was neutral. (auth)

14983 INFLUENCE OF THE GASTROINTESTINAL IODIDE CYCLE ON THE EARLY DISTRIBUTION OF RADIOACTIVE IODIDE IN MAN. Marguerite T. Hays and David H. Solomon (Univ. of California, Los Angeles). J. Clin. Invest., 44: 117-24(Jan. 1965).

The salivary-gastric-enteric cycle of radioiodide (^{131}I) was studied during the first 3 hr after isotope administration in nine normal subjects. Radioiodide in the thyroid, plasma, urine, and pooled salivary-gastric secretions was measured frequently. Control sessions for each subject were identical, except that no secretions were aspirated from the gastric tube. Radioiodide recovered from the stomach averaged 23% of that administered (range, 11 to 44%). Thyroidal clearance averaged 16 ml per min; renal clearance, 34 ml per min; and gastrosalivary clearance (not corrected for dead space), 46 ml per min. When gastric contents were removed, the nonthyroidal, nonurinary volume of distribution remained constant (averaging 20.11 or 27% of body weight) after the first hour, and plasma radioactivity declined along a simple exponential curve. The rate of this decline could be accounted for by the summed thyroidal, renal, and gastrosalivary clearance rates. In the control sessions, the increase in volume of distribution persisted longer, and in four subjects it was still evident at 180 min. Thyroid/plasma ratio became constant after 1 hr, but was not as good a predictor of nongastrointestinal volume of distribution as was body weight. Curves of plasma radioactivity in the control sessions varied greatly among the individuals and did not follow a simple exponential function. This difference must be due to the effect of intestinal reabsorption of radioiodide previously cleared. (auth)

14984 THE METABOLISM OF MAGNESIUM IN THE NORMAL RAT. J. G. Chutkow (Argonne Cancer Research Hospital, Chicago). J. Lab. Clin. Med., 63: 80-?(1964). (ACRH-22(p.1-19))

Whole-body counting and ^{28}Mg were used in studies on Mg metabolism in rats. Data are included on the effects of varying amounts of Mg on Mg metabolism. (C.H.)

14985 THE SITES OF MAGNESIUM ABSORPTION AND EXCRETION IN THE INTESTINAL TRACT OF THE RAT. J. G. Chutkow (Argonne Cancer Research Hospital, Chicago). J. Lab. Clin. Med., 63: 71-?(1964). (ACRH-22(p.20-8))

Magnesium metabolism within the alimentary tract of rats was studied using ^{28}Mg as a tracer. Data on sites of Mg absorption and excretion are presented. (C.H.)

14986 METABOLITES OF LITHOCHOLIC ACID-24-C^{14} IN HUMAN BILE AND FECES. A. Norman (Stockholm's Lans Centralasarett, Danderyd and Karolinska Inst., Stockholm) and R. H. Palmer. J. Lab. Clin. Med., 63: 986-?(1964). (ACRH-22(p.65-81))

Lithocholic acid is an endogenous steroid which has recently been shown to have potent pyrogenic and inflammatory activity in man and to produce cirrhosis of the liver in several species. It is present in human bile and feces, and, because of its extremely toxic properties, is a substance of potential pathogenic significance in various diseases of the gastrointestinal tract. Data are presented concerning the metabolites of orally-administered lithocholic acid-24-^{14}C in human bile and feces. (auth)

14987 INTERNAL DOSIMETRY STUDIES OF RADIOPHARMACEUTICALS. I. TOLPOVIDONE ^{131}I. Jonathan P. Miller, Ann Dalziel, and L. E. Michael Crawford (Abbott Labs., Chicago and Abbott Labs., Oak Ridge, Tenn.). J. Nucl. Med., 6: 59-68(Jan. 1965).

The distribution and effective half life of Tolpovidone–^{131}I (^{131}Raovin) was studied in both rats and cats. The data are extrapolated to man to estimate the radiation dose delivered during the use of ^{131}Raovin for brain-scanning and diagnosis of hypoalbuminemia. Radiation dosage calculations indicate that a 30 μC dose of Tolpovidone–^{131}I delivers considerably less radiation than maximum permissible quarterly occupational exposure limits and that a 500 μC dose of Tolpovidone–^{131}I delivers less radiation than established yearly exposure limits. Data are tabulated. (auth)

14988 ABSORPTION AND EXCRETION OF ^{131}IODINE LABELED ATABRINE. Leopoldo Jose Anghileri (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Med., 6: 69-74(Jan. 1965).

The absorption and excretion of a cold preparation of ^{131}I-labeled Atabrine in rats was studied. Data on the distribution of ^{131}I in various organs and tissues in the rats are tabulated. Analysis of the ^{131}I-labeled Atabrine indicated the presence of two compounds, a minor one with Rf value 0.3–0.4 and a major with Rf value 1.0. The minor component was excreted rapidly and the major component was excreted more slowly. In agreement with this, high activity was found in the stomach and the maximum of labeled Atabrine was found in the kidneys at 3 hr. (P.C.H.)

14989 SYNERGISTIC EFFECTS OF AEROSOLS. IV. THERAPEUTIC ELIMINATION OF INHALED RADIOACTIVE PARTICLES. Charles W. LaBelle, Dorothea M. Bevilacqua, and Heinrich Brieger (Jefferson Medical Coll., Philadelphia). J. Occupational Med., 6: 391-5(Oct. 1964).

Rabbits were given intratracheal injections of radioactive silver iodide and treated with inhalation of inert carbon particles, expectorant drugs, and a semiliquid diet. The lasting lung and body burdens of radioactive isotope in these animals were approximately only one-third as large as those in untreated control animals. A similar procedure may provide a decontaminating treatment in cases of accidental human exposure to radioactive particles. (auth)

14990 GONAD EXPOSURE DUE TO I-131 THYROID FUNCTION TEST. II. CORRECTION FOR ANALYTICAL FORMULA AND ESTIMATED VALUE. Hideo Irie, Kenji Takeshita, Koichi Murakami, Shigeaki Okamura, Junnosuke Matsuoka, Hitoshi Katayama, and Seiichi Yoshimoto (Kyushu Univ., Fukuoka). Kyushu J. Med. Sci., 13: 245-50(Oct. 1962).

In a previous study, the amount of ^{131}I excreted in urine was linear in semi-logarithmic plots (log time, t, vs μC ^{131}I excreted) within the first to 24 hr after administration. The formula derived was a logarithmic projection, unsuitable for direct comparison with a measured integral dose. The amount of ^{131}I retained in the bladder is expressed as E_n, the total exposure dose E is: $E = \Sigma_{n=0}^{n} E_n$, where n is the frequency of urine discharge. If y is the cumulative urinary excretion of ^{131}I: $y = (y_n - y_0/\log 23)\log t + y_0$ where y_0 is the extrapolated y value at the first hour, and y_n is the total amount of ^{131}I excreted within 24 hr after administration. If the frequency of urine discharge between the first hour and 24th hr after administration of ^{131}I is N and the urine discharge is the nth one, and if it is assumed that the time interval between each urine discharge is the same, t can be replaced by $(23n/N + 1)$. The corrected formula to use to calculate the total gonad dose D_{24} within 24 hr after administration of ^{131}I is: $D_{24} = 0.265 \times 10^{-3}$ (MR/hr·μC) × f × E (μC·hr)$(10^4/8^2)$ MRad; if f = 0.97 (for 0.36 Mev γ-ray), $D_{24} = (0.462/N)Y_n$ MRad. After correction (correction factor, 0.95) for the effects of absorption and scattering due to tissue between source and the gonad, $D_{24} = (0.439/N)Y_n$ MRad (in water). Comparison between corrected estimates and measurements of gonad exposure due to ^{131}I accumulated in urinary bladder gave an average ratio for the first day in 30 cases of 1.08. In 14 cases, for 5 days after administration the average ratio was 1.34. When these ratios are used as correction factors, the gonad dose will be; $D_{24} = 1.08 \times (0.439/N)Y_n = (0.474/N)Y_n$; $D_{120} = (0.588/N)Y_n$. The dose D_{120}

delivered to the gonad within 120 hours after ^{131}I administration is due to ^{131}I accumulated in the urinary bladder, when most of the exposure takes place. (BBB)

14991 BABIES' INTAKE OF STRONTIUM. Elsie M. Widdowson and G. E. Harrison (Cambridge Univ., Eng.). Lancet, 2: 753-4(Oct. 3, 1964).

Although strontium in drinking-water contributes little to the total daily intake of a British adult, it is pointed out that the amount of Sr a baby will ingest is increased when it is fed commercial dried infant foods reconstituted with tap water rather than distilled water. A baby consumes ten times as much water per kg body weight as the adult, and, if the baby is fed on a dried-milk preparation, any extraneous material in the tap water used for making up its food will be consumed. In London water the concentration of stable Sr is 27.5 μg/100 ml. An intake of 500 ml water will therefore provide the London baby with about 140 μg of stable Sr a day. In addition to the Sr in tap water, the bottle-fed baby will get all the Sr originally present in the fresh milk which was dried in the preparation of the infant food. One commercial dried-milk preparation, made from dried whole cow's milk and lactose, contains 360 μg/100 g, which is 50% higher than the Sr in fresh milk. If the baby has 85 g of this powder a day, this will provide 305 μg Sr; hence the total daily intake will be 445 μg. A baby on undiluted fresh whole cow's milk will consume about 250 μg stable Sr a day and a breast-fed baby only 44 μg. These considerations are important if retentions of Sr are being measured, and it was found that tap water can provide a large part of a baby's intake of Sr when the feeds of two babies, whose Sr balance was being studied, were made up with tap water instead of distilled water. Stable Sr, as far as known is completely harmless, but similar calculations can be made for other elements or substances which may not be so innocuous. (BBB)

14992 DESCRIPTION OF THE SUBSTANCES USED IN FAT ABSORPTION EXAMINATIONS AND ANALYSIS OF TRIOLEIN LABELED WITH ^{131}I. Istvan Elekes (MTA Orvosradiologiai Kutatocsoport, Budapest). Magy. Radiol., 16: 267-9(Oct. 1964). (In Hungarian)

After a brief discussion of radiolabeling various triglycerides used in medicine, attention is focused on triolein and its use in diagnosis. It was found that best results were achieved when its biochemical and physiochemical characteristics remained unchanged during labeling with ^{131}I. The labeling is satisfactory only if no more than 1% of the olefins contained in the molecules are saturated with iodine. A procedure for determining the amount of I addition is described. It was found that 20°C was the optimal temperature for conducting the tests. (TCO)

14993 THE DISTRIBUTION OF P^{32} IN A NORMAL MAMMARY GLAND. I. P. Melenchuk (Sechenov Inst. of Medicine, USSR). Med. Radiol., 9: No. 11, 23-8(Nov. 1964). (In Russian)

By measuring the emission 24 hours after administration, a tracer study was made on the distribution of ^{32}P in mammary glands of 95 women. The resulting figures were compared against those characterizing radiation recorded over the hip, taken for 100%. In women with both mammary glands being healthy, the intensity of the ^{32}P radiation increased over the glands at the time of puberty and diminished somewhat in the period of extinct menstrual function. Over the nipple the radiation was 2–3 times as high as in the gland quandrants, where its distribution was almost uniform. In women with affected mammary glands (malignant tumor, a limited form of dyshromonal hyperplasia) radiation over the indurated site was more intensive. In other areas of the gland the tracer distribution was similar to that found in healthy mammary glands at the time of puberty in women. (auth)

14994 DISTRIBUTION OF RADIOACTIVE CHROMIUM PHOSPHATE AND ZIRCONYL PHOSPHATE COLLOIDAL SOLUTIONS IN ANIMAL ORGANISM IN DIFFERENT ROUTES OF ADMINISTRATION. E. S. Kiseleva and S. L. Daryalova (Gertsen Scientific-Research Inst. of Oncology, USSR). Med. Radiol., 9: No. 11, 29-36(Nov. 1964). (In Russian)

The distribution of colloidal solutions of chromium phosphate and zirconyl phosphate in the organism of animals (rabbits, rats) in different routes of administration was studied. A long-term deposition of radioactive colloidal particles at the site of introduction was found, which enables a small volume of tissues to be irradiated with large doses. The colloid is absorbed mainly by the lymphatic system with accumulation in regional lymph nodes. However, a relatively high percentage (up to 13.1%) of ^{32}P accumulation was revealed in the bone marrow; this may be due to pollution of the colloidal solution with free ions of radiophosphorus or to the liberation of radiophosphorus ions in the organism associated with the instability of the chemical bond in the chromium phosphate molecule. (auth)

14995 URANYL IONS AND INTESTINAL HEXOSE TRANSFER. H. Newey, P. A. Sanford, and D. H. Smyth (Univ. of Sheffield, Eng.). Nature, 205: 389-90(Jan. 23, 1965).

The effects of uranyl nitrate on hexose transfer in the rat small intestine was investigated. Experiments were carried out on sacs of rat everted small intestine, and the transferase of glucose, galactose, and fluid were examined in the presence of uranyl nitrate. In concentrations from 10^{-5} to 3×10^{-4}M, glucose entry from the mucosal fluid was reduced from 55 to 40 mg/hr, while glucose metabolism was unaffected. These concentrations also reduced the fluid transfer stimulated by glucose initially present in the mucosal fluid but not by glucose initially present in the serosal fluid. This supports the view that uranyl nitrate at these concentrations inhibits the entry of glucose into the epithelial cell from the mucosal fluid. In higher concentrations uranyl nitrate (3×10^{-3}M) reduced glucose metabolism from 19 to 9 mg/hr. When glucose and galactose were initially present together with uranyl nitrate, galactose transfer was inhibited. Explanations for this are given. (P.C.H.)

14996 EVIDENCE FOR THE EXISTENCE OF NON-EXCHANGEABLE CALCIUM IN HUMAN URINE. J. D. Pearson (Guy's Hospital Medical School, London). Nature, 205: 410-11(Jan. 23, 1965).

An experiment is described that demonstrates a non-exchangeable Ca fraction in normal human urine and presumably in the plasma. The effective non-exchangeable Ca (C_{NE}) is defined as that amount of unlabeled Ca that would have to be present in processed urine to account for any difference in its specific activity compared with that of the original specimen; though this almost certainly represents an oversimplification. It was found that the urines examined contained variable amounts of effectively non-exchangeable Ca, in two cases exceeding 40%. It was evident that this fraction is firmly bound since it was not removed by a strongly acidic unifunctional resin; increasing the incubation period to 48 hr had little effect, and in several experiments increasing the pH to 10 or more also had little effect. (P.C.H.)

14997 KINETIC REGULARITIES OF STRONTIUM YIELD FROM CYSTOSEIRA BARBATA. G. G. Polykarpov and V. S. Ten. Nauchn. Dokl. Vzsshei Shkoly, Biol. Nauki, No. 4, 89-97(1962). (In Russian)

Measurements of ^{90}Sr accumulation by C. barbata placed in sea water for various time intervals following culture in radioactive sea water for 3 hrs or 2 days are tabulated. The ^{90}Sr yield was exponential in algae remaining in pure sea water for 24 hrs. The length of time that C. barbata was in solution containing ^{90}Sr affected the rate of its secretion in pure water. Different ^{90}Sr secretion rates from C. barbata remaining from 0 to 24 hrs in pure sea water suggested Sr binding with the biosubstratum by various algal cell forms. (R.V.J.)

14998 NEUTRON ACTIVATION ANALYSIS OF COLLOIDAL GOLD IN BIOLOGICAL MATERIAL. STUDIES ON COMPARISON BETWEEN THE DISTRIBUTION OF RADIOACTIVE COLLOIDAL GOLD ^{198}Au AND THAT OF NON-RADIOACTIVE COLLOIDAL GOLD. Yasuhiro Katakura (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 485-92(Aug. 1964). (In Japanese)

Nuclear reactor JRR-1 was used for the neutron activa-

tion analysis of colloidal gold distribution in rat tissues, and the differences between the distribution of radioactive colloidal gold and that of non-radioactive colloidal gold were studied. A dose of 500 μC of radioactive colloidal gold or about 150 μg of non-radioactive colloidal gold in 0.5 ml of saline solution was given to each rat, which was sacrificed at various intervals after the treatment. After a period of time allowing for decay of radioactive colloidal gold, pieces of the tissues about 0.5 g in weight were dried and reactivated by bombardment of thermal neutron flux (3×10^{11} n/cm^2 sec) in the nuclear reactor JRR-1. Ten micrograms of standard gold samples were used as a control. The reactivated colloidal gold in the tissues was measured selectively by a single-channel gamma-ray spectrometer, and without chemical separation it was possible to determine the amount of colloidal gold to the order of 10^{-6}g among the other elements in the tissues. It was found that the distribution of radioactive colloidal gold is somewhat different from that of non-radioactive colloidal gold, especially in the spleen. (auth)

14999 TOXICITY OF SULFUR-35, SELENIUM, AND TELLURIUM TO AVIAN EMBRYOS. P. L. Wright and F. R. Mraz (Univ. of Tennessee, Oak Ridge). Proc. Soc. Exptl. Biol. Med., 118: 534-9(Feb. 1965).

The effects of inorganic ^{35}S, was compared with those resulting from toxicosis by two other chalcogens, Se and Te. Continuous internal irradiation of chick embryos with ^{35}S administered on the 4th or 8th day of incubation produced abnormalities similar to those observed in Se toxicosis of avian embryos. The highest level of ^{35}S (1600 μC) injected into eggs containing 4-day embryos produced morphological abnormalities more severe than those produced by the same level of ^{35}S administered to 8-day embryosis, or by any level of stable Se tolerated. Se at levels greater than 30 μg killed all the embryos within 24 hr after injection. Nearly 20 times more Te than Se was required to kill all the embryos within 24 hr; no abnormalities were observed in the Te-injected embryos. It was concluded that the abnormalities in avian embryos resulting from internal irradiation by ^{35}S are very similar to those observed from Se toxicosis. Data are tabulated. (P.C.H.)

15000 IMMUNOLOGICAL PROPERTIES OF SILICA AND BERYLLIUM COMPOUNDS. G. A. Voisin, A. Collet, J. C. Martin, H. Daniel-Moussard, and F. Toullet (Hospital Saint-Antoine, Paris and Centre d'Etudes et Recherches des Charbonnages de France, Verneuil-en-Halatte). Rev. Franc. Etudes Clin. Biol., 9: 819-28(Oct. 1964). (In French)

Five groups of guinea-pigs were prepared to assess the direct antigenicity and the ability to induce auto-antigens of soluble and insoluble silica and beryllium. The origin, whether autologous or homologous, of the antigen responsible for the previously described delayed hypersensitivity reaction to guinea pig leucocytes was sought. One group of animals acted as controls and received no injections. Each of the other groups received injections of one of the following: quartz; beryllium oxide; silicic acid; or beryllium sulfate. All the animals were tested for skin hypersensitivity to the above four agents as well as against homogenates of quartz granulomata beryllium oxide granulomata, sodium sulfate and homologous phagocytes. Serum antibodies were looked for against the first six substances in the animals by incaus of passive cutaneous anaphylaxis test. No circulating antibody could be detected by passive cutaneous anaphylaxis against the test substances. Neither quartz, silica, or beryllium sulfate induced any specific cutaneous hypersensitivity (immediate, Arthus or delayed). Homogenates of quartz or beryllium granulomata did not detect sensitization to a possible autoantigenic modified substance. Beryllium oxide induced, inconsistently and feebly, a specific delayed hypersensitivity to beryllium oxide (and possibly sulfate). It was concluded that quartz, silicic acid, and beryllium sulfate do not act as antigens. (P.C.H.)

15001 STUDY AND DETERMINATION OF ^{90}Sr IN SAMPLES OF HUMAN AND ANIMAL BONE. NOTE II. M. Zanetti and F. Cutrufelli (Universita, Bologna). Riv. Ital. Igiene, 23: 63-8(Jan.-Apr. 1963). (In Italian).

Twenty-five samples were examined. Seven samples from cattle, aged 4 months to 6 years, had ^{90}Sr–^{90}Y contents ranging from 6.13 to 20.02 strontium units (S.U.), mean 9.98 S.U. The samples were taken from March to December 1962 and the content generally decreased with age of the animal. Three samples from horses (8 months–1 year) taken in December 1962 ranged from 14.74 to 31.82 S.U. Five samples from sheep taken in December 1962 gave 13.40 S.U. for an animal aged 3 months; two aged 1 and 1.5 years gave 130.96 and 138.28 S.U.; two aged 4 and 5 years gave 25.45 and 20.24 S.U. For bone samples from nine human subjects ranging in age from 18 to 81 years (eight men, one woman) the values ranged from 0.00 S.U. from femurs of two men aged 63 and 61 years to 2.92 S.U. from a rib of the woman, aged 18. The data are corrected for the whole skeletal system and then range from 0.00 to 2.49 S.U.; all data were taken from March to December 1962. The mean for the whole skeletal system was 0.89 S.U., and the mean absorbed dose in bone tissue ranges from 0.00 to 7.25 MRem/year. The high corrected data are for a sample from a 60-year-old man. It was concluded that the animal bone concentration is directly connected with the type of diet and that the mean concentration in human bones is slightly higher than that for the previous year. (BBB)

15002 HEMOGLOBIN SYNTHESIS IN MARROW CELL CULTURE: THE EFFECT OF RAT PLASMA ON RAT CELLS. O. Gallien-Lartigue (College de France, Paris) and E. Goldwasser. Science, 17: 277-?(1964). (ACRH-22 (p.45-7))

Hemoglobin synthesis was studied in rat bone marrow cells in tissue culture using ^{59}Fe as a tracer. The substitution of fetal calf serum for rat serum in the media resulted in a decrease of hemoglobin radioactivity by about 50%. When the Fe was bound to the fetal calf serum, while the remainder of the protein part of the medium was rat plasma, the amount of ^{59}Fe in the hemoglobin was reduced to about one-sixth that found when the medium was all rat plasma, but when the main part of the protein consisted of fetal calf serum and the Fe was bound to rat plasma the label in hemoglobin was increased more than threefold. These data were interpreted as indicating that the marrow cells in culture can synthesize hemoglobin at an accelerated rate when provided with some factor, possibly nutritional, in fetal calf serum. (C.H.)

15003 UPTAKE BY PLANTS OF Cs-137, Ce-144, AND Y-91 AS INFLUENCED BY RHIZOSPHERE OXYGEN TREATMENTS. D. E. Birkie, J. Letey, N. T. Coleman, and W. F. Richardson (Univ. of California, Riverside). Soil Sci., 99: 93-7(Feb. 1965).

Radionuclide uptake and accumulation by plants was studied under various oxygen concentrations in the root environment. The nuclides used in the experiments were ^{137}Cs, ^{144}Ce, and ^{91}Y. Tomatoes, beans, and barley were grown in both solution culture and a soil-sand mixture. Results from the solution cultures indicate that uptake of all three elements into the shoots of beans increases with increasing oxygen concentration around the roots. Radionuclide accumulation in tomatoes was not affected greatly by oxygen treatment. In barley, the radionuclide concentration in the shoots was little affected by oxygen concentration, but in the roots there was a tendency for the ion concentration to increase with increasing oxygen concentration at the root. In the soil, very little activity caused by ^{144}Ce and ^{91}Y was found in the shoots of any of the plants. ^{137}Cs was accumulated in the leaves of all three plants and the differences in ion concentration due to oxygen treatment were greater. A decrease in ^{137}Cs concentration as the oxygen concentration increased was observed in tomatoes. No generalizations as to radionuclide uptake as a function of oxygen concentration about the roots were found. (auth)

15004 PROCEEDINGS OF 3rd ANNUAL MEETING OF THE JAPANESE ASSOCIATION OF NUCLEAR MEDICINE, NOV. 22, 23, 1963. VOL. 3. Tokyo, The Japan Radioisotope Association, 1964. 75p.

Ninety-three articles or abstracts of articles are included. None of the articles was abstracted separately in NSA. (P.C.H.)

15005 RADIOTOXICITY OF INTERNALLY DEPOSITED RADIOACTIVE MATERIAL. Stanton H. Cohn and James S. Robinson. p.251-80 of "Atomic Medicine, Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The radiation hazard from radionuclides located within the body is considered from the point of view of long-term effects produced by internally deposited isotopes with long radioactive and biological half-lives, accumulated doses of short-lived as well as long-lived isotopes, and high doses to individual tissues resulting from selective localization of isotopes. Internally deposited radioactive materials are associated primarily with β and α particles, and to a much lesser extent with γ rays, but once they are taken into the body they irradiate the body continuously until they are eliminated by biological turnover and physical decay. The two most important routes of admission of radioactive materials into the body are via the respiratory system and the gastrointestinal tract, though they may also enter by cuts in the skin. Radioactive materials entering the body through ingestion and inhalation are deposited in vital organs where they bombard radiosensitive tissues, such as bone marrow and thyroid, until the material is removed from the body by natural processes or radioactive decay. Radiation hazards from internally deposited ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{131}I, ^{239}Pu, ^{137}Cs, and also radiation hazards from biologically important fission products in fallout are discussed. The hazards of internally deposited radiation resulting from reactor accidents or radiological warfare are considered briefly. Methods for the diagnosis and treatment of radioactive poisoning by the use of emetics, cathartics, or precipitating agents to retard gastrointestinal absorption and the use of decalcification therapy, complexing agents, chelating agents, or colloidal ion exchange carriers to increase elimination of deposited radioisotopes are discussed. (110 references.) (C.H.)

15006 RADIOISOTOPE DILUTION AND SPACE STUDIES. Prentiss M. Dettman. p.403-16 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Applications of radioisotopes and the dilution principle in studies of body composition are discussed. The dilution principle is reviewed and uses of radioisotopes for the in vivo determination of total body water, extracellular water, exchangeable Na, and exchangeable K are discussed in detail. The relation of the results of these measurements to body metabolism in health and disease is discussed. Applications of whole-body counting systems for measurements of the whole-body retention of an administered isotope are also discussed. (49 references.) (C.H.)

15007 SOME CHARACTERISTICS OF THE IODINE METABOLISM IN THE INTERNAL IRRADIATION DAMAGE OF THE THYROID GLAND. M. Jovanovic, Dj. Djurdjevic, and J. Sinadinovic (Institut za Primenu Nuklearne Energije, Zemun, Yugoslavia). Vienna, International Atomic Energy Agency, 1964, Preprint SM-53/30, 16p. (CONF-641105-2)

From Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology, Prague.

The effects of large doses of radioiodine on the percentage deposition of ^{131}I in the thyroid gland, urinary excretion of radioisotope, pattern of histological localization as shown by autoradiograms, and on the relative amounts of various organic iodine compounds present in the thyroid gland in the blood was studied in rats. Doses of 2, 10, and 150 μC/100 g body weight were used. Twenty-four hours following the dosage, even the largest dose used did not provoke any morphological changes that could be established histologically. Thyroid uptake and urinary excretion during the first day after dosage were approximately equal in per cent to the tracer and largest (150 μC) dose. Autoradiographic investigations demonstrated that doses of 150 μC led to disturbances in the transport of iodine organic fractions from the epithelial cells to the colloid, even in the first day. Thus initial functional disturbances of the thyroid cells and of the iodine metabolism may be expected. Other disturbances were also observed between the first and fifth day after large doses of ^{131}I. (P.C.H.)

15008 THE PHYSIOLOGICAL ROLE OF IRON IN NUTRITION OF GROWING PIGS. S. L. Hansard, F. H. Hoskins, J. V. Lowe, and D. M. Thrasher (Louisiana Agricultural Experiment Station, Baton Rouge). Vienna, International Atomic Energy Agency, 1964, Preprint SM-53/11, 19p. (CONF-641105-3)

From Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology, Prague.

Radiochemical data from a series of studies with swine during gestation, lactation, and early post partum are reported. Iron and ^{59}Fe readily traversed the placenta from sow to fetus at all trimesters of pregnancy, but quantity and efficiency of transfer were greatest during the latter stages of gestation. Fetal-fluid concentration gradients favored iron movement from placenta to the litter, but net efficiency of absorbed dietary transfer was low (2.2%). Mammary tissue appeared to be more permeable to ^{59}Fe at parturition (P) than at P + 10 days, and more injected than absorbed ingested iron was transferred to milk. Supplemental dietary iron increased milk iron values, but levels were considered inadequate to support hemoglobin levels in growing pigs. Plasma appeared to be the principal source of iron for both fetal and milk iron. Nursing pigs absorbed and utilized iron efficiently for red cell production with insignificant endogenous loss and the data provided bases for estimating physiological iron needs of nursing pigs. Feed-lot trials demonstrated feasible approach for hemoglobin maintenance in growing pigs by dietary means. (P.C.H.)

Radiation Effects

Refer also to abstracts 15262, 15264, 15265, and 15267.

15009 (AMRNL-279) HISTOPATHOLOGY OF MICE FED IRRADIATED FOODS. Samuel W. Thompson, Ronald D. Hunt, and John F. Ferrell (Army Medical Research and Nutrition Lab., Denver, Colo.). July 15, 1963. 78p. (AD-423051). $8.60(CFSTI).

A total of 4000 mice of the Cb and Strong A strains were fed a composite diet composed of pork, chicken, milk, carrots, and potatoes which was 100% irradiated, a similar diet in which only one component was irradiated, the same diet non-irradiated, or a commercial pellet diet. Cardiac auricular dilatation and rupture reported to have been produced in these strains of mice by the irradiated diets employed was not observed in any mouse in any diet group of this study. An evaluation of all lesions observed in the various phases of this study indicated that no lesion occurred with significantly increased frequency in the irradiated diet groups. (auth)

15010 (BNL-7815) NINE SHORT ARTICLES [ON STUDIES OF ZEA MAYS]. H. H. Smith (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Results are reported from a series of studies on the genetic effects of colchicine, ethyl methane sulfonate, x radiation, fast neutrons, and beams of muons and π mesons in seed of maize, Zea mays. An attempt was made to establish the mechanisms of mutation induction after exposure to the various mutagens. (C.H.)

15011 (BNL-7890) CHANGES IN RADIOSENSITIVITY OF ROOTS OF GLYCINE MAX (L.) MERRIL, DURING POST-DORMANT REACTIVATION. Jerome P. Miksche (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Individual germinating seed of Glycine max were exposed to x rays at five 24-hour intervals and then returned to controlled growing conditions. Collections of nonirradiated plant material were made at the same five 24-hour intervals for the purposes of DNA estimation and anatomical-cytological information. Dry weights of root mate-

rial were determined after a 30-day growth period. The average nuclear volume of the root meristem cells increased and reached a maximum at 48 hours. The amount of DNA per meristem cell reached a peak at 72 hours. The highest radioresistance was observed at 24 hours and the greatest radiosensitivity was at the 72-hour DNA peak, or 24 hours after maximum nuclear volume enlargement. These findings indicate that in a vegetative organ the amount of DNA per cell is more strongly correlated with radiosensitivity than is nuclear volume. (auth)

15012 (BNL-7898) DISCREPANCIES IN MITOTIC CYCLE TIME WHEN MEASURED BY TRITIATED THYMIDINE AND COLCHICINE. THE EFFECT OF TRITIATED THYMIDINE ON THE G_1 PERIOD DURATION. J. Van't Hof (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 17p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The mitotic cycle of Pisum root meristem cells at 20°C ± 1° was measured by labeling with ^{3}H-thymidine for 30 minutes and observing the sequential appearance and disappearance of labeled mitotic figures, treatment with 3.76×10^{-4} M colchicine for 30 minutes, and observing the eventual appearance of tetraploid mitotic figures and simultaneously treating the meristems with ^{3}H-thymidine and colchicine. The latter procedure distinctly marked cells in two different segments of the mitotic cycle. Cells entering mitosis were affected by colchicine in such a manner as to prevent cytokinesis but not karyokinesis; these cells appeared as tetraploids in the subsequent mitosis and thereby provide a measurement of the mitotic cycle duration. Since DNA synthesis in Pisum takes place approximately midway in interphase, ^{3}H-thymidine labeled cells appear in mitosis before the tetraploid cells. When the ^{3}H-thymidine labeled cells are in division, the tetraploid cells are in interphase and vice versa. Thus the combined use of ^{3}H-thymidine and colchicine provide a quick and accurate measurement of the interphase period durations. The results indicate that the first mitotic cycle following pulse labeling with ^{3}H-thymidine averages 1.4 times longer than that measured with colchicine, and the increase in the cycle time brought about by ^{3}H-thymidine occurred in G_1. (auth)

15013 (CONF-551-3) VALUE OF INDUCED MUTATIONS FOR QUANTITATIVE CHARACTERS IN PLANT BREEDING. R. E. Scossiroli (Pavia Univ. (Italy). Istituto di Genetica). [1964]. Contract [AT(30-1)-2466]. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Technical Meeting on the Use of Induced Mutations in Plant Breeding Programs, Rome, May-June 1964.

In the course of evolution from wild ancestors to the present types, our crop plants have undergone profound changes in consequence of directed selection in the presence of special environmental conditions and in conditions of less intense competition. Such evolution has been possible only because variability for different morphological or physiological traits was available. For a long time the raw material for breeding better types has been supplied by existing variability coming from the spontaneous mutation process or hybridization procedures. Muller's discovery of induced mutability opened a new field in plant breeding, making new variation for major and minor genes available to selection. Experiments performed on different crop plants, including peanuts, soybeans, white mustard, yellow seed lupine, tobacco, Arabidopsis, tomato, barley, rice, oats, wheats, maize, and cotton are reviewed and discussed with references to the effects of radiation on quantitative traits. A reduction of the mean and a significant skewness of the distributions for some characters was found. An increase of variation due to a larger genetic variability was found as a general effect on radiation-induced mutations for minor genes which determine, together with the environment, the quantitative phenotype. From the point of view of plant breeding this effect of radiation is very important because larger genetic variation means larger responses to selection. (auth)

15014 (CONF-641002(p.82-7)) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE OF 34 TO 50F. (Continental Can Co., Inc., Chicago, Ill.).

Results are reported from studies on the effects of NaCl, temperature, low level ionizing radiation, $NaC_7H_5O_2$, and $NaNO_3$ on the outgrowth of spores of Type E Clostridium botulinum. (C.H.)

15015 (N64-29573) STUDY OF THE CORRELATION BETWEEN LINEAR ENERGY TRANSFER AND RELATIVE BIOLOGICAL EFFECTIVENESS. Final Report, July 1963–August 1964. (Avco Corp., Tulsa, Okla. and Oklahoma Univ., Norman. Research Inst.). Contract NASw-782. 70p. $2.00(CFSTI).

Instrumentation and biological systems were developed to study the correlation between linear energy transfer (LET) and relative biological effectiveness (RBE). The instruments developed for this program include small tissue equivalent proportional counters for measuring LET spectra over a wide range of radiation intensities and tissue equivalent ionization chambers for the direct measurement of radiation absorbed dose in tissue. In the biological system development, living tissue was simulated by compacting haploid yeast cells (strain Sc-7) in solid polyethylene glycol. The compacted mass of cells was irradiated and serial sections were taken to assay radiation damage at various depths. The ability of the irradiated cells to produce a macroscopic colony on suitable nutrient material was a measure of cell survival. Radiation exposures were made with 22.3 Mev and 210 Mev protons, and the results were compared with 200 KVCP x-ray irradiation results. The slopes of the yeast cell survivors versus absorbed dose curves were found to be directly related to average LET. It is felt that a significant biological tool was developed which could be used for radiation additivity studies, microbeam radiation damage studies, and other related research problems. The results presented in this report also indicate that the radiation quality sensors could be used to examine the radiation environment in space. (auth)

15016 (NP-14408) BELKOVYE FRAKTSII SEMENNIKOV RAZLICHNYKH ZHIVOTNYKH V NORME I POSLE LUCHEVOGO POVREZHDENIYA. (Protein Fraction in Testes in Various Animals under Normal Conditions and after Radiation Injuries). A. M. Alekseeva and N. N. Kolosova (USSR). [nd]. 4p. Dep.(mn).

Investigations were made of the chemical composition and metabolism in testes of various animals suffering from radiation injuries. The protein composition was changed during testis atrophy induced by local x irradiation. The amount of soluble protein decreased, whereas scleroprotein increased. Guinea pigs testes contained a smaller amount of scleroprotein than other animals examined. (R.V.J.)

15017 (NYO-901-4) CHROMOSOME ANALYSIS AS AN INDICATOR OF RADIATION EXPOSURE. Lorraine Meisner (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst. [Apr. 13, 1964]. Contract AT(30-1)-901. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Ionizing radiation induces chromosome aberrations, possibly in a random fashion, but the type and frequency of the observed aberrations differ as a function of dose, forms of application, site irradiated, and length of time since exposure. Results are reviewed from chromosome analysis of cultures of peripheral lymphocytes from 109 cancer patients who had been exposed to therapeutic doses of radiation and 34 controls. It was concluded that chromosome analysis is a useful method for diagnosing past radiation exposure. (C.H.)

15018 (ORNL-P-758) LETHAL, MUTAGENIC AND CYTOGENETIC EFFECTS OF FAST, CHARGED PARTICLES ON VARIOUS BIOLOGICAL MATERIALS. G. E. Stapleton (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 16p. (CONF-720-8). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Results are reported from comparative studies of the lethal, mutagenic, and cytogenetic effects of a number of

fast, charged particles in Escherichia coli. The radiations used included protons ranging in energy from 22 to 750 Mev, carbon ions, helium ions, 250-Kvp x radiation, 1.2 to 1.4-Mev photons, fission neutrons, and 2.5 and 14.1-Mev neutrons. An analysis of the results revealed large gaps in the present assessment of the role of LET in the relative biological effectiveness of protons, as well as other types of radiation. (C.H.)

15019 (RRA-N318) IONIZING IRRADIATION AND ITS EFFECT UPON THE HEALING WOUND. Annual Report, November 1, 1962–October 31, 1963. B. L. Reynolds (Radiation Research Associates, Inc., Fort Worth, Tex.). Contract DA-49-193-MD-2368. 7p. (AD-425214). $1.10 (CFSTI).

Progress is reported in studies on the effects of doses of 200 to 1000 R ionizing radiation on wound healing in laboratory animals. Emphasis was placed on the development of methods for the separation of organic and inorganic substances in tissue biopsy specimens through the use of sound sources for tissue homogenization and the use of several organic solvents for phase separation; the separation of classes of similar organic substances in the same solution through phase and centrifugation techniques, the use of thin-layer chromatography, and the use of dual column chromatography; and the analysis of separated classes of compounds using stable column techniques. (C.H.)

15020 (TID-20442) BREEDING VALUE OF THE RADIATION INDUCED MACROMUTANT. II. EFFECT OF MUTANT EXPRESSION AND ASSOCIATED BACKGROUNDS ON SELECTION POTENTIAL IN ARACHIS HYPOGAEA L. D. A. Emery, W. C. Gregory, and P. J. Loesch, Jr. (North Carolina Agricultural Experiment Station, Raleigh). [1964]. Contract AT(40-1)-1747. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The use of mutations induced by x radiation in peanut (Arachis hypogaea) breeding programs is discussed. Emphasis is placed on the effect of macro-mutant expression on the modificatory role of its genetic background in hybrid combinations with other mutant backgrounds, the quantitative variations in the backgrounds of macro-mutants when random samples of the same hybrid population are evaluated, and the usefulness of background variations in plant breeding programs. (C.H.)

15021 (TID-21526) ATTEMPTS TO DEVELOP MAMMALIAN SYSTEMS RESISTANT TO IONIZING RADIATION. Final Report. Glynn P. Wheeler (Southern Research Inst., Birmingham, Ala.). Sept. 22, 1964. Contract AT(40-1)-3093. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Heterogeneous populations and partially synchronized populations of cultured mammalian cells were exposed to various doses of x rays, and the effects upon cellular multiplication and survival in swirl cultures were determined. Surviving cells were cultivated in static cultures on glass, and the cells of the resulting sheet were irradiated. Several serial exposures to x rays were carried out in this way. Cells with increased resistance to x rays were not obtained. A subline of hamster plasmacytoma No. 1 that was resistant to 1,3-bis(2-chloroethyl)-1-nitrosourea was not cross-resistant to x rays, and serial x irradiation of this tumor in vitro and of tumors of the parent line in vivo did not yield resistant sublines of the tumors. Leukemia L1210 ascites cells that were resistant to 1,3-bis(2-chloroethyl)-1-nitrosourea were not resistant to x rays or to gamma rays. (auth)

15022 (USNRDL-TR-799) STUDIES ON THE RADIOSENSITIVE PHASE OF THE PRIMARY ANTIBODY RESPONSE. I. TRANSFER OF ANTIBODY FORMATION TO IRRADIATED ANIMALS BY SENSITIZED MACROPHAGES AND NORMAL LYMPHOID CELLS FROM NON-IRRADIATED RABBITS. J. F. Pribnow and M. S. Silverman (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 7, 1964. 21p.

Irradiated rabbits receiving both rabbit peritoneal monocytes incubated with bovine gamma globulin and lymph node cells from the monocyte donors were able to produce antibody. Irradiated rabbits injected with sensitized monocytes alone failed to show an antibody response. Normal recipients of these cells exhibited a typical primary antibody response, although titers were lower than in controls receiving antigen alone. Normal and irradiated rabbits receiving lymph node cells incubated with antigen also failed to produce antibody, as did irradiated rabbits receiving simultaneous injection of antigen and lymph node cells. The implications of these findings in relation to the radiosensitive phase of the immune response and to current concepts of the mechanism of antibody synthesis are discussed. (auth)

15023 (FTD-TT-64-644) EFFECT OF IONIZING RADIATION ON THE LEVEL OF HISTAMINE IN THE TISSUES AND ITS SIGNIFICANCE IN EARLY RADIATION DAMAGE TO THE HISTOHEMATIC BARRIERS. E. (Ye.) I. Krichevskaya and G. V. Kapitonova. Translated from Gisto-Gematicheskie Bar'ery, Akad. Nauk SSSR, Inst. Biol. Fiz., Tr. Soveshch., Moscow, No. 48, 48-56, May 25-28, 1960(Pub. 1961). 14p. (AD-607563). $1.00(CFSTI).

The role of the histohematic barrier in radiation injury was investigated. The free histamine content in skin, kidneys, liver, and brain of rats, guinea pigs, and rabbits was determined after exposure of the animals to single doses of 800 to 1000 R x radiation. The effects of the administration of ACTH or cortisone before or after irradiation, and the effects of anesthetics, antihistamine preparations, and denerving on the content of free histamine in the tissues of the irradiated animals were measured. The effects of polymyxin B, which causes the release of histamine from fatty cells, on the penetrability of the histohematic barrier were studied in mice. Results indicate that changes in the histamine content of tissues of irradiated animals are the result of systemic effects. No definite conclusions were reached as to the role of histamine in the radiation syndrome. (C.H.)

15024 (OTS-64-11410/4(p.524-33)) STUDIES ON THE COAGULATION AND FIBRINOLYTIC SYSTEM IN LETHALLY IRRADIATED DOGS. Zenon Wegrzynowicz, Maria Kopec, Zbigniew Lattałło, and Edward Kowalski. Translated from Arch. Immunol. Therap. Exptl., 12: No. 4, 524-33(1964).

The pathogenic factors involved in the mechanism of hemorrhagic diathesis in radiation sickness was investigated in dogs exposed to whole-body doses of 600 R x radiation. A battery of 19 tests was used to determine radio-induced changes in coagulation and the fibrinolytic system. Results indicated a decrease in coagulability and a simultaneous increase in the level or activity of some plasma factors. Possible mechanisms involved are discussed. (C.H.)

15025 DEVELOPMENT OF EXPERIMENTAL ENCEPHALITIS IN MICE INFECTED WITH TICK VIRUS AND IRRADIATED WITH β AND γ RAYS. N. Cajal, N. Draganescu, and O. Burducea (Institutul de Inframicrobiologie al Academiei R.P.R., Bucharest). Acad. Rep. Populare Romine Studii Cercetari Inframicrobiol., 4: 17-21(1963). (In Romanian)

The effect of internal irradiation on progress of encephalitis in virus-inoculated mice was studied. Both sexes of mice of a hybrid strain were intracerebrally inoculated with tick-borne encephalitis virus of the Bucharest F strain. The mice were then injected intraperitoneally with 0.5-ml solutions (with a sp act. of 50 μC/ml) of $Na_2H^{32}PO_4$ or $Na^{131}I$. This provided for internal β or γ irradiation of the mice, respectively, with 25 μC doses. The incubation period for development of encephalitis was shorter (three days) in mice injected with the isotopes than in control mice (four days). Mortality was 100% in all three groups, the mean survival times being 4.7 days in uninjected controls, 3.9 days after ^{131}I injection, and 4.5 days after ^{32}P injection. Greater synthesis of virus particles was noted in the ^{131}I-injected animals' brain and in the ^{32}P-injected animals' spleen. The virus titers, as LD_{50} values, were as follows for control, ^{131}I-treated, and ^{32}P-treated mice: brain $10^{-5.3}$, $10^{-7.7}$, $10^{-5.2}$; plasma 10^{-5}, $10^{-5.8}$, $10^{-4.2}$; and spleen $10^{-2.1}$, $10^{-2.5}$, and $10^{-3.3}$. On the

basis of these results it is suggested that fallout radioactivity from thermonuclear weapons tests may influence human susceptibility to virus diseases, especially encephalitides. (BBB)

15026 ELECTROPHORETIC STUDY OF SERA OF ANTI-INFLUENZA IMMUNIZED RATS TREATED WITH RADIOPHOSPHORUS (^{32}P) AND RADIOIODINE (^{131}I). O. Burducea, I. Samuel, and M. Cepleanu (Institutul de Inframicrobiologie, Academiei R.P.R., Bucharest). Acad. Rep. Populare Romine Studii Cercetari Inframicrobiol., 13: 89-96(1962). (In Rumanian)

To investigate the effect of internal irradiation on serum proteins and antibodies, adult rats were injected intraperitoneally with ^{131}I and ^{32}P. These isotopes were injected in doses of 25 μC as 0.5 ml of solutions of $Na^{131}I$ and $Na_2H^{32}PO_4$ with specific activities of 50 μC/ml. A control group was injected with stable I and P solutions. For immunization, type A influenza virus was injected at 7-day intervals. Nine days after the last inoculation with virus, the isotope solutions were injected. Blood samples were taken four and 20 days later. Antibody formation, as measured by the hemagglutination-inhibition reaction, was slightly reduced by ^{131}I administration at four days but ^{32}P did not affect the serum antibody level. The serum γ-globulin level was markedly increased four days after ^{131}I injection (to 22.3% from a normal level of 14.5%); it then decreased at 20 days to near-normal levels. γ-Globulins were only slightly elevated after ^{32}P injection. Treatment of the rats with stable I and P had little influence on serum γ-globulin concentrations. Injection of both stable and radioactive I and P markedly decreased the β-globulin levels at the four-day interval. Both ^{131}I and ^{32}P tended to decrease the serum albumin/globulin ratio. (BBB)

15027 EXPERIMENTS ON THE CARCINOGENIC EFFECT OF HYDROGEN PEROXIDE AND ON THE MECHANISM OF RADIOCANCEROGENESIS. Ferdinand Schmidt (Deutsche Akademie der Wissenschaften zu Berlin, Potsdam-Rehbuecke, Ger.). Acta Biol. Med. Ger., 13: 74-85 (1964). (In German)

Single or repeated 0.1-ml injections of 0.6% H_2O_2 in Ringer's solution were made subcutaneously into the back of newborn mice. In other experiments H_2O_2 was first mixed with rat serum and after decomposition of the H_2O_2 by the serum catalase, the mixture was injected into mice of the AB strain. In another series of tests, mice were whole-body x irradiated with 750-R doses and 8 hr later filtrates of their erythrocytes, liver, and spleen were injected in newborn mice. In all these experiments the number and type of tumors developing in the injected animals were recorded. A 28% tumor yield after H_2O_2 injection in 72 mice was seen after a minimum survival of 6 months. Separate evaluation of experiments, in which the animals received one or three H_2O_2 injections, gave an increase in tumor yield from 20 to 33%; the latent period was reduced from 20 to 15 months. Cancer of the breast was increased in mice injected with rat serum treated with H_2O_2 in vitro. However, the findings of others relative to the carcinogenic effect of the plasma from lethally totally irradiated mice could not be confirmed. It is suggested that, in comparison to the ~400 known chemical substances with carcinogenic effects, hydrogen peroxide occupies a special position, not only for its simple structure, but for the short duration of action of the native substance, which surpasses that of any other chemical cancerogen. (BBB)

15028 ON THE EFFECT OF X RAYS ON THE INCORPORATION OF ^{35}S-SULFATE INTO THE RAT AORTA. J. Kunz, H. Braselmann, and O. Keim (Humboldt Universitat, Berlin). Acta Biol. Med. Ger., 13: 228-32(1964). (In German)

Twenty male rats were irradiated a single time with 500 R of either whole-body or thoracically directed x ray. One day later they were injected intraperitoneally with 0.5 mC of $Na_2{}^{35}SO_4$/100 g body wt, and then killed 1 day later. The ascending, descending, and abdominal aortas were removed and defatted. The concentrations of ^{35}S were assayed radiometrically. The incorporation of ^{35}S in the aorta walls was significantly increased in the irradiated animals as compared to normal control animals. Similar results were confirmed by autoradiographic studies, but these differences were not quantitated. Differences in metabolic activity were observed autoradiographically not only between various segments of the same aorta section, but also between portions of the same histological section. No histological differences between the aortas of irradiated and control animals were observed. It was not possible to ascertain whether the differences in ^{35}S uptake were due to incorporation during synthesis of mucopolysaccharide molecules or simply to exchange of S. (BBB)

15029 THE OVARIAN CELLS AS AFFECTED BY DIRECT AND GENERAL X-RAY IRRADIATION. M. Palkovits, E. Czeizel, I. Palkovich, and Gy. Vaczo (Medical Univ., Budapest). Acta Chir. Acad. Sci. Hung., 4: 1-7 (1963).

Mice were irradiated with 500 R and the ovaries were examined at various intervals. Irradiation was carried out in three different ways. The first group of animals received whole-body irradiation in ventro-dorsal direction, the second was irradiated similarly but with local protection of the ovaries, whereas the third group received direct irradiation of only the ovary. In the second series mice were irradiated with different doses: 50, 100, 300, 500, 1000, and 1500 R, again in three groups. After local 500-R irradiation of the ovary the nuclei of the follicular cells were found to be swollen. Maximum change was observed 2 hr after exposure. The indirect radiation effect (ovary shielded) caused only moderate swelling of the follicle cells in the first two days; 64 hr after exposure the increase of nuclear volume was definite, and even in the 128th hour after irradiation it was significantly higher as compared to the control. After whole-body irradiation two peaks were observed on the karyometric curve. The maximum of the first corresponded to the effect of direct radiation occurring after about 8 hr; the second peak, flatter and more protracted, was observed in the 64th hour; this maximum is due to the indirect radiation effect. In the second experimental series the increase of nuclear volume paralleled the dose; the larger the dose reaching the ovary, the more swelling occurring in the nuclei of the follicular cells. However, above 500 R the increase of nuclear volume no longer paralleled the dosage. Histologic study of the ovary revealed that if the ovary is not protected, cell injuries are caused already by 50 R doses. Indirect radiation produced no pathologic changes in the cells at the 50 R level; however, after exposure to 1500 R cell destruction was seen in the ovary after direct and whole-body irradiation. Pathologic cell forms dominated the histological picture and atypical cell division was also observed. (TCO)

15030 EFFECT OF LARGE DOSES OF RADIOIODINE ON THYROID FUNCTION. II. HORMONE SYNTHESIS. M. Jovanovic, Dj. Djurdjevic, and J. Sinadinovic (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine and Forestry, Zemun, Yugoslavia). Acta Endocrinol., 6: 9-13(Jan. 1965).

The effects of large doses of radioiodine on the relative amounts of various organic iodine compounds present in the thyroid glands of rats were studied. At 24 hours there was no effect of radiation from ^{131}I on the relative amounts of diiodotyrosine, monoiodotyrosine, and thyroxine plus triiodothyronine found in the gland. After 48 hours and 5 days, during which time there is known to be considerable destruction of epithelial cells, there was an inhibition of thyroxine synthesis but not of the iodination of tyrosine. There is evidence that even at some days after irradiation at the levels used some follicles are preserved and able to synthesize hormones. (auth)

15031 RADIATION EFFECTS ON ELECTROLYTE AND WATER BALANCE, PARTICULARLY ON EXTRACELLULAR ION SHIFTS. Z. Zsebok and Gy. Petranyi, Jr., (Univ. Medical School, Budapest). Acta Med. Acad. Sci. Hung., 19: 11-21(1963).

Adult rats were irradiated with 1500 R of 200 kv whole-

body x radiation at a rate of 35 R/min. During the first 24 hr postirradiation polyuria, polydipsia, enhanced gastric secretion, and increased extracellular space were observed. There was a rise in the total sodium and potassium contents of the extracellular fluid with concurrently decreased Na and increased K excretion. On the second day after irradiation both the water and the electrolyte balance became negative. This shift was due to anorexia and failure to retain electrolytes and water. The low ionic content of the extracellular fluid indicates disturbed ion turnover caused by slow and reversed peristalsis, so that the intestinal juice is unable to reach the large intestine where the Na could be reabsorbed. At about 72 hr, the electrolyte and water balance is suddenly upset: the extracellular space decreased to 10%, the total Na decreased by 41%, and the total K by 60%. After the 67th postirradiation hr, the epithelial lining of the gut began to necrotize, the intestinal wall gradually became denuded, and completely lost both its active and passive capacity for ion transport. The result is unimpeded movement of water and ions from the extracellular space into the intestinal tract. The salt and water loss may be one of the direct etiologic agents in gastrointestinal radiation death. (BBB)

15032 STUDIES ON THE ACQUIRED RADIORESISTANCE OF THE EHRLICH ASCITES TUMOR. G. G. Markov (Biochemical Research Lab., Bulgarian Academy of Sciences, Sofia). Acta Unio Intern. Contra Cancrum, 20: 1352-4(1964).

The acquired radioresistance of a hyperdiploid strain of the Ehrlich ascites carcinoma after repeated x irradiation in vivo (cumulative dose up to 82,000 R) was investigated. Dry weight, cell volume, nucleic acids content per cell, and karyotypes of two radioresistant sublines were studied. The results reject the possible role of the polyploidy in the acquired resistance, this latter being a result of variability and selection in the tumor cell population in the course of repeated x irradiation. (auth)

15033 RADIOSENSITIVITY OF TUMOR CELLS OF DIFFERENT PLOIDY IN THE PRESENCE AND ABSENCE OF OXYGEN. U. Norman and L. Revesz (Karolinska Institutet Medical School, Stockholm). Acta Unio Intern. Contra Cancrum, 20: 1355-8(1964).

Two sublines, containing hyperdiploid and hypertetraploid cells respectively, were isolated from the same Ehrlich ascites tumor. After x irradiation in vitro, either in the presence of oxygen or under anoxic conditions, the sublines were grown intraperitoneally in mice in plastic diffusion chambers that excluded interaction with host cells. The size of the cell population was determined quantitatively at various intervals after implantation. After treatment with identical doses of x ray under anoxic conditions, the hypertetraploid subline began to multiply earlier and eventually reached a larger population size than did the hyperdiploid subline. Conversely, when irradiation was done in the presence of oxygen, no differences were observed between the growth curves of the two sublines, although both showed increased sensitivity to the x ray. The growth of unirradiated controls of the two sublines was similar to each other. In the absence of oxygen the correlation between chromosome number and radiosensitivity suggests that injury to genetic material is the major cause of cell death. The abolition of this correlation by the presence of oxygen is consistent with the possibility that in this instance some other mechanism may be responsible for cell death. (auth)

15034 ELECTRON MICROSCOPY OF RAT MAMMARY GLANDS ON LACTATION, HORMONAL STIMULATION, AND IN THE CASE OF POSTRADIATION FIBROADENOMA. Yu. S. Chentsov. Acta Unio Intern. Contra Cancrum, 20: 1377-8(1964).

A comparative electron microscopic study of the rat mammary gland during lactation hormonal stimulation by injection of synestrol or progesterone and after radiation in case of fibroadenoma is described. The results are briefly discussed. Data on ultrastructure of the mammary gland on lactation are in good agreement with others. (P.C.H.)

15035 ON MALIGNANT LIVER AND BILE DUCT TUMORS IN CASES EXPOSED TO THOROTRAST AND AMONG WINEGROWERS WITH LONG-STANDING EXPOSURE TO ARSENIC. B. Larsson (Gustaf Werner Inst. for Nuclear Chemistry, Uppsala). Acta Pathol. Microbiol. Scand., 58: 399(1963).

Data on the two groups are briefly presented as available in the literature. The nonepithelial tumors were considered mainly. Some differences in carcinogenesis between the radioactive ThO_2 and the chemically toxic As_2O_3 were revealed. The Th-induced sarcomas appeared after an average of 16 yr, and the As induced tumors after 20 yr. It is evident that different substances can induce similar tissue responses. In the present two sarcoma groups there was one cellular response and one terminal lesion. Human tumors exogenously induced and certain characteristics in the response of some animal species to carcinogenic influences are considered to present a basis for further study of the common denominators in the process of malignant development. (BBB)

15036 RADIATION RESISTANCE OF STREPTOCCUS FAECIUM AND SPORES OF BACILLUS SUBTILIS DRIED IN VARIOUS MEDIA. Ebbe Ahrensburg Christensen and Knud Sehested (Statens Seruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand., 62: 448-58(1964).

The radiation resistance was determined on two strains of S. faecium and on spores of two strains of B. subtilis dried in air after suspension in various media and storage for various periods. In addition, the radiation resistance of the spores was determined before and after cleaning, and after culture at 45°C. Resistance to ionizing radiation of S. faecium as well as B. subtilis spores was found to be highest if they were dried in a protein-containing medium. Unwashed spores had a greater resistance than washed spores. Culture at higher temperature and heat activation at 80°C for 10 min had no influence on the resistance of the B. subtilis spores. In relation to the present study, it is recommended that doses in radiation sterilization should be indicated as min doses and, if equality is to be established between the effect of radiation sterilization and the effect of heat sterilization, it should be based on the max resistance of the most resistant ones of the commonly occurring microorganisms, under the conditions prevailing during the given sterilization procedure. A dose of 2.5 Mrad is used at several centers as a routine dose for sterilization of medical equipment. This dose gave an inactivation factor of only 10^2 to 10^3 for the S. faecium strains studied, when the strains were dried in serum broth. This factor is very low in comparison with the effect of autoclaving under the conditions usually recommended. At Riso, the Research Establishment of the Danish Atomic Energy Commission, the sterilizing dose for disposable items of hospital equipment is at present 4.5 Mrad. (auth)

15037 UNUSUAL BENIGN AND MALIGNANT SEQUELAE TO CHILDHOOD RADIATION THERAPY INCLUDING "UNILATERAL HYPERLUCENT LUNG." Walter E. Berdon, David H. Baker, and John Boyer (Columbia Presbyterian Medical Center, New York). Am. J. Roentgenol., Radium Therapy Nucl. Med., 93: 545-56(Mar. 1965).

Infants and children treated by irradiation for both benign (hemangiomas) and malignant disease (Wilms' tumor, neuroblastoma, retinoblastoma) have shown radiation induced growth disturbances on serial studies. Undergrowth, vertebral distortion resembling Morquio's spondyloepiphyseal dysplasia, severe muscle and bone atrophy, and malignant transformation (osteogenic sarcoma arising 10 years after treatment of a retinoblastoma) are discussed. Radiation effects were found to be related to the age of the patient, the nature of the primary disease, and the amount and quality of the radiation that was delivered. An unusual case of unilateral hyperlucent lung in a patient cured of metastatic Wilms' tumor is presented. A proposed mechanism involving the bronchial artery-pulmonary artery shunting, and related to the metastasis, the radiation, and intercurrent pneumonia, is discussed. (auth)

15038 CARCINOMA OF THE THYROID IN A BEAGLE. A. C. Andersen and R. M. Johnson (Univ. of California, Davis). Am. J. Vet. Res., 25: 861-4(May 1964).

A description is given of the morphologic characteristics of thyroid carcinoma that developed in a female beagle subjected to whole-body x irradiation. At 10 months of age, she was given two exposures of 50 R, separated by a 28-day interval (total dose 100 R). At nine years of age, the dog's general appearance and condition began to decline, as seen by a roughened coat, graying about the head, lethargy, and variable appetite. An enlargement (2 by 3 cm) was palpated in the left thyroid region; the mass was circumscribed and hard. The slowly developing nodule of one thyroid gland became painful upon palpation during terminal illness, which was characterized by anorexia, progressive ascites, respiratory rales, and ascites. Lymph node, lung, liver, and adrenal gland metastases were found. Variable degrees of anaplasia were found in metastases similar to that found in man and lower animals. Thus in some organs small anaplastic cell masses were characteristic whereas in others larger anaplastic cells were diffusely located in areas of edema, hemorrhage, and parenchymal necrosis. Histologic study of the primary neoplasm (left thyroid) revealed a well-differentiated adenocarcinoma. Although less differentiated areas existed, micro- and macro-follicles were represented in all sections of the primary neoplasm. (BBB)

15039 RHEUMATIC MANIFESTATIONS FOLLOWING TREATMENT OF HYPERTHYROIDISM WITH RADIOACTIVE IODINE. H. Bloch-Michel, G. Valle, and P. Bion (Hopital Tenon, Paris). Ann. Endocrinol. (Paris), 25: 319-22(May-June 1964).

A survey was made of early and late sequelae of radioiodine treatment at one hospital. On the basis of a study of 600 cases treated with radioiodine, comprising patients with hyperthyroidism of euthyroidism with cardiac insufficiency, the relatively frequent occurrence of rheumatic complications in the course of treatment is pointed out. (TCO)

15040 A HISTOCHEMICAL EXAMINATION OF ENZYMATIC CHANGES IN RATS MADE HYPERTENSIVE BY X-RAY EXPOSURE. Robert W. McKelvey and Geoffrey H. Bourne (Emory Univ., Atlanta). Ann. Histochim., 8: 339-48 (July-Sept. 1963).

Enzyme changes were studied in various tissues of rats made hypertensive by one 1200 R exposure to x rays, localized to both kidneys. Qualitative and semi-quantitative changes were followed in the distribution of succinic dehydrogenase, alkaline phosphatase, 5-nucleotidase, adenosine triphosphatase, glucose-1-phosphatase, and glucose-6-phosphatase. Staining for total lipids and phospholipids was also done, and change in collagen and elastic fiber distribution was also determined. Animals whose kidneys were irradiated showed a stronger activity for glucose-6-phosphatase than unirradiated controls, but less strong than the thigh-irradiated controls. For succinic dehydrogenase the localization and the shift in relative activity showed the same pattern as that found for glucose-6-phosphatase. Adenosine triphosphatase was most concentrated in the proximal tubules, and at 24 hr after irradiation, the enzyme in the kidney of the kidney-irradiated and irradiated controls showed more activity than the control. The irradiated control had slightly more enzyme activity than the irradiated kidney animal. One month after irradiation, the control animals had the highest activity. 5-Nucleotidase was most concentrated in the proximal convoluted tubules, and 24 hr after irradiation, the irradiated control rats showed highest enzymatic activity, while the control animals show the least. One month after irradiation, the kidney 5-nucleotidase activity in all rats was nearly equal. Alkaline phosphatase was most concentrated in the proximal convoluted tubules, and 24 hr after irradiation, the control irradiated rats showed the highest activity. The kidney-irradiated animal shows only a slightly stronger reaction than the control. For glucose-1-phosphatase the enzymatic reaction and localization was similar to ATPase. Sections of kidneys stained for lipid, phospholipid, collagen, elastic, and reticular fibers showed no significant difference among the various groups of animal. The other tissues studied (heart, liver adrenal, and muscle) showed no significant change in the animals from any of these groups. This generalized immediate enzymatic stimulation by irradiation is presumably a response on the part of the tissues to regain equilibrium from the physical and chemical damage caused by irradiation. (TCO)

15041 MALIGNANT LYMPHOMA IN SURVIVORS OF THE ATOMIC BOMB IN HIROSHIMA. Robert E. Anderson and Kenzo Ishida (Atomic Bomb Casualty Commission, Hiroshima). Ann. Internal Med., 61: 853-62(Nov. 1964). (TID-21164)

An increased prevalence of Hodgkin's disease, lymphosarcoma, and multiple myeloma in proximally located survivors of the atomic bomb in Hiroshima who had surgical or post-mortem examinations at Atomic Bomb Casualty Commission (ABCC) is reported. The occurrence of reticulum cell sarcoma appeared to be decreased in this same group of individuals. The pathologic material demonstrating these relationships consisted of 91 cases of unequivocal malignant lymphoma and was drawn from two essentially independent ABCC sources, the autopsy series and diagnostic lymph node biopsies. A consideration of the epidemiologic features of this case material supports the view that this increase in prevalence is a reflection of the occurrence of lymphoma in the general population of individuals exposed within 1,400 m of the hypocenter. In addition, proximally exposed persons autopsied at ABCC tend to die at an earlier age than distally exposed or nonexposed individuals. The lymphomas examined in exposed and nonexposed individuals showed no morphologic differences attributable to radiation between the corresponding diagnostic categories. (P.C.H.)

15042 THE RESULTS OF GAMMA IRRADIATION OF THE BACILLUS SUBTILIS SPORE ON THE GERMINATION OF THE SPORE AND ON VEGETATIVE GROWTH. J. Hermier (I.N.R.A., Jouy-en-Josas, France). Ann. Nutr. Aliment., 17: 439-47(1963). (In French)

The spores of Bacillus subtilis were irradiated with ^{60}Co γ rays and the number of surviving spores determined by counting the colonies after four days incubation in a medium of glucose-ammonium-mineral salts with L-alanine added. In a nonirradiated group, 88% of the spores germinated, 88% reached the prevegetative stage, and there was colony development of 78%. After a dose of 0.2 Mrad, 85% of the spores germinated, 95% reached the prevegetative stage, and the percentage of colonies was 2.05%. After 0.4 Mrad, germination took place in 89% of the spores. Prevegetative cells developed from 61% and colonies, from 0.83%. After irradiation with 0.6 Mrad, spore germination was 81%, prevegetative cell development was 62% and colonies developed in 3.2×10^{-3}% of the spores. After a dose of 3 Mrad, spore germination was 64%. There was no prevegetative development, and colonies developed in only 10^{-15}% of the spores. Irradiation with 0.2 to 0.6 Mrad did not inhibit germination. When the spores, instead of being irradiated, were heated to 100°C, the effects on germination were quite different. After one-half hour of heating, 92% of the spores germinated, 90% formed prevegetative cells, and 68% formed colonies. After one-hour exposure 89% germinated, 95% formed prevegetative cells and 26%, colonies. After two hours, 91% germinated, 82% formed prevegetative cells, and 9%, colonies. After 3 hours, 78% germinated, but only 1% formed prevegetative cells and 3%, colonies. After 4 hours only 4% germinated, 1% formed prevegetative cells, and 1%, colonies. To determine the vegetative growth of B. subtilis spores after irradiation, the germinated spores were sown in a medium of Difco yeast extract, 0.1% glucose, and 0.1M mineral salts, kept at 45°C. In the control group 86% of the spores reached the prevegetative stage, 86% formed microcolonies (more than 16 cells, but not visible to the naked eye), and 88% formed colonies. After 0.05 Mrad, 86% became prevegetative cells, 86% formed microcolonies, and 28% formed macrocolonies. After 0.1 Mrad 45% of the spores formed prevegetative cells, 44% formed microcolonies, and 12%,

macrocolonies. After 0.15 Mrad 12% reached the pre-vegetative stage, 10% formed microcolonies, and 4%, macrocolonies. The diminution in the number of colonies produced by irradiated spores was explained by a growth retardation after the fourth cell division, an effect of doses of 0.1 Mrad or more. In a nonsporulating micro-organism growth inhibition follows almost immediately after irradiation. The culture medium has no significant influence on the number of irradiated B. subtilis spores which survived. Colonies in a minimum medium of glucose-ammonium-mineral salts survived as well as those in a more favorable medium of 1% yeast extract, 0.1M glucose, and mineral salts. In nonsporulating micro-organisms the number of cells surviving after irradiation depends on the nutritive medium. (BBB)

15043 EFFECT OF IONIZING RADIATION ON THE VITAMIN CONTENT OF SEVERAL ALIMENTARY PRODUCTS. Anne-Marie Le Clerc (Laboratoire Centrale des Subsistances, Paris). Ann. Nutr. Aliment., 17: B449-61 (1963). (In French)

Various foods were exposed to a ^{60}Co source at a dose rate of 100,000 R/hr, except eggs, where the dose rate was 67,600 R/hr. Meat, vegetables, wheat, fruit juices, eggs, and a vitamin oil were examined for vitamins C, B_1, B_2, A, and total carotenoids by standard techniques. In vegetables studied, vitamin C content is lowered by 30 to 60% by 15,000 R, but this value does not appreciably change on further irradiation. No change was observed in vitamin B_1, but a possible slight increase in vitamin B_2 was noted after 45,000 R. Deterioration in vitamin B_1 and C was seen in orange juice after 500,000 R, but not for vitamin B_2. For tomato juice, deterioration of vitamin B_1 occurred even after 10,000 R, and after 100,000 R for vitamin C; there was none for vitamin B_2. Deterioration of vitamin C in cherry and cassia juice was much less to nil; there was also less marked vitamin B_1 deterioration. Beef vitamin B_1 content dropped 65% after 4,500,000 R; mutton B_1, 50%; pork B_1, 96%. In precooked ham, only 28% destruction was noted for vitamin B_1 after 500,000 R. Vitamin A content of egg yolk decreased 82% after 600,000 R; total carotenoids, 62%. Vitamin A content of a vitamin oil did not decrease until after 200,000 R, but fell 20% at 600,000 R. It is possible to irradiate foods with less than 500,000 R without intensive destruction of water-soluble vitamins. (BBB)

15044 AN INVESTIGATION OF THE CELL DIVISION ACTIVITY OF X IRRADIATED LARVAE OF TRITON PUNCTATUS. Thydsen Meinertz (Universitat, Copenhagen). Arch. Entwicklungsmech. Organ., 154: 195-215 (1963). (In German)

An investigation of the mitotic activity in the cornea of x irradiated larvae of Triton punctatus and Axoloten larvae was initiated and three research series, with x-ray doses in the ratio of $1-\frac{1}{8}-\frac{1}{20}$, were set up. A corresponding number of unirradiated larvae were used as controls. The results are represented graphically and they agree satisfactorily with the results of others. The number of prophases and metaphases was the same as in normal research conditions. The length of the period with reduced mitotic activity was dependent on the x-ray dose, with a longer period for high doses. Along with decreasing mitotic activity there was also a decrease in the percentage of prophases with respect to the total number of mitoses. The percentage of prophases increased very sharply with increasing or preserved mitotic activity and formed in the first hours of the study a clear curve apex that was proportionately higher after strong irradiation than after weak irradiation. The period of decreasing mitosis lasted approximately 6 hrs, notwithstanding the x-ray dose, unless it was very low (15 R and under). Retardation occurring in the cell division directly after irradiation caused a very intensive activity in the hours that can be shown graphically in the curve apex. It was proposed that very low doses possibly can cause a stimulation of the cell division activity. Pycnotic mitoses and greatly changed mitoses occurred only with very strong irradiation. (tr-auth)

15045 ACCIDENTAL ACUTE RADIATION INJURY. Gould A. Andrews and Roger J. Cloutier (Oak Ridge Inst. of Nuclear Studies, Tenn.). Arch. Environ. Health, 10: 498-507(Mar. 1965).

The various types of acute exposure that are possible and the signs and symptoms that may be observed in radiation injury are summarized. For simplicity, exposures are divided into external and internal for each of the more common types of radiation. General information regarding the various types of radiation and their possible external hazard is given. (P.C.H.)

15046 UNUSUAL CLINICOPATHOLOGICAL SYNDROMES WITH KAPOSI'S VISCERAL AND RELATED SARCOMATA: REPORT OF THREE CASES, ONE ASSOCIATED WITH THORIUM DIOXIDE ADMINISTRATION. Henry T. Perkins, Jr., John V. Verner, Jr., Tatsuo Yoneyama, and E. Harvey Estes, Jr. (Univ. of Florida, Gainesville). Arch. Internal Med., 105: 733-45(May 1960)

Three cases are presented in which widespread vascular tumors were found at autopsy to explain the often unusual clinical syndromes preceding death. The finding in one young woman of a hyperdynamic circulation and striking heart failure in association with a huge liver with an overlying bruit led to the correct antemortem diagnosis of a vascular tumor involving the liver. One young man had received thorium dioxide 18 yr prior to death from a widespread tumor that seemed to involve the organs where residual Th radioactivity was most concentrated. An elderly man had suffered from an unexplained anemia for five years before developing a disease characterized by skin rash and abdominal discomfort. At autopsy, each case demonstrated widespread tumors involving many organs and similar to those tumors termed Kaposi's visceral sarcoma. The literature is reviewed and possible origins of the Kaposi tumor discussed. (TCO)

15047 EXPERIMENTAL AND THEORETICAL STUDIES ABOUT THE RELATIVE BIOLOGICAL EFFECTS OF NEUTRONS. VI. "TISSUE-EQUIVALENT" DEPTH DOSIMETRY OF FAST NEUTRONS WITH THRESHOLD DETECTORS. D. Piroth, E. H. Graul, and H. Krueger (Philipps-Universitat, Marburg, Ger.). Atompraxis, 11: 33-7(Jan. 1965). (In German)

Studies were made on the determination of the energy distribution of fast neutrons in tissue-equivalent material (water) with the use of suitable threshold detectors. First, the spectra at particular water depths were calculated with the use of certain orthonormal functions. From this, the course of the depth dose as a function of water depth was calculated, using an extension of the mathematical formalism required hitherto. The results show that significant data can be obtained with only four detectors. The depth-dose curve shows a definite dose maximum inside the irradiated body; this is in agreement with theoretical expectations. It was found that the results can be improved by using additional detectors. The method is subject to a margin of error of ±5%, aside from the fluctuations caused by using the procedure of mathematical approximation. (auth)

15048 ALTERATIONS IN THE STRUCTURE OF DNA AT THE ACUTE DEATH OF THE CELL AFTER WHOLE BODY IRRADIATION. P. Schaefer and U. Hagen (Universitat, Freiburg i. B.). Atompraxis, 11: 41-5(Jan. 1965). (In German)

In thymus and bone marrow of mice the number of pycnotic cells and the viscosity of the deoxyribonucleic acid were determined after whole-body irradiation. In the thymus the viscosity of the DNA decreased after the death of the lymphocytes. This degradation was due to an intracellular activation of the deoxyribonuclease. In the bone marrow the degradation of the DNA was only found after high doses. After low doses the degradation of DNA was missed although numerous pycnotic nuclei were observed in the erythroblasts. It was concluded the the pycnosis of the nucleus and the degradation of the DNA are effected independently of each other. (auth)

15049 ON LUNG CHANGES AND LUNG TUMORS IN RATS AFTER IRRADIATION WITH RADIOACTIVE STRONTIUM (^{90}Sr). H.-W. Altmann, W. Hunstein, and E. Stutz

(Universitat, Wurzburg, Ger.). Beitr. Pathol. Anat. Allgem. Pathol., 124: 145-75(1961). (In German)

Small Plexiglas capsules that each contained from 27 to 62 μC of ^{90}Sr-^{90}Y were inserted beneath the diaphram in 134 white Wistar rats ~105 days old. These were allowed to remain in place for a period of several months. After intervals that ranged from 5 to 8 months portions of the right lungs of the animals that had been exposed to the β irradiation from the pellets showed interstitial fibrosis, and in 68 animals, lung tumors were observed. The tumors that had developed were squamous cell carcinomas, with cornified structures. They occurred in the diaphram, anterior mediastinum, and sometimes even invaded the right auricle. The tumors seemed to have a multilocular origin, and developed from cell masses in the region of the small bronchi and alveoli, where they appeared to range from an essentially benign metaplasia to typical squamous cell formations. It was impossible to detect any sharply defined limit between benign and malignant stages of growth, because over the many months of observation there was a continuous range of development present, from completely undifferentiated tissue to growing sarcomatous tumors. The one most definite conclusion drawn was that the growths originated from the epithelium of the smaller bronchi and bronchioles. Besides the lung tumors, other tumors that may have resulted from the β irradiation were observed in the upper right portion of the body. These included 3 mammary carcinomas, 3 cornified squamous cell carcinomas of the skin, and 5 sarcomas of the chest wall. (BBB)

15050 THE COMPARISON OF RADIATION AND ANTIMETABOLITE RESPONSES OF GENETICALLY ALTERED MURINE LEUKEMIC CELLS. Glenn A. Fischer and Carl F. von Essen (Yale Univ., New Haven). Biochem. Pharmacol., 14: 95-104(Feb. 1965).

By clonal isolation from diploid P815Y cells, two hyperdiploid lines and one hypertetraploid line were selected for study. Cell-reproduction studies demonstrated that the hypertetraploid line was sensitive to chronic γ irradiation and to cytosine arabinoside, but was unaltered in sensitivity to all other agents investigated, when compared with the diploid and hyperdiploid lines. Different leukemic cell lines (P815Y, L5178Y, and MLSY) could be characterized in culture by differences in sensitivity to antimetabolites. Drug-resistant clones isolated from sensitive populations of L5178Y cells, with but one exception, were unaltered in sensitivity to other antimetabolites. (auth)

15051 THE DECISIVE IMPORTANCE OF DPNase ACTIVATION FOR THE DPN DECREASE IN IRRADIATED ASCITES TUMOR CELLS. H. Hilz, P. Hlavica, and B. Bertram (Universitat, Hamburg). Biochem. Z., 338: 283-99(1963). (In German)

The hypothesis that a leak of nicotinamide from irradiated ascites tumor cells leads to activation of DPNase was confirmed. On irradiation, ^{14}C-nicotinamide leaves the labeled cells and appears in the medium; intracellular concentration of nicotinamide in normal cells is so high that the ascites cell DPNase must be inhibited to at least 45% of normal, and a leak in the inhibitor from the cells therefore should result in an activation of the enzyme. On incubation of a concentrated, irradiated cell suspension the nicotinamide leaking out becomes diluted only slightly in the medium resulting in a still partial inhibition of the DPNase. Therefore, a small irradiation effect is seen in contrast to a more diluted cell suspension showing a much greater irradiation injury. DPNase inhibitors can block the decrease in DPN only when they are added immediately after irradiation, before the increase in DPNase activity has developed. Nicotinic acid, which does not inhibit the DPNase, also cannot prevent the irradiation-dependent decrease in DPN concentration in spite of the fact that after irradiation it is still incorporated effectively into DPN. The primary and decisive action of irradiation (and certain cytotoxic substances) on these parameters seems to concern an active principle affecting the cell membranes (nicotinamide permease). Its destruction leads to a rapid equilibration of the intracellular nicotinamide with the external medium. (TCO)

15052 HISTONE SYNTHESIS AFTER INHIBITION OF DEOXYRIBONUCLEIC ACID REPLICATION. Joseph A. Ontko and Wells R. Moorehead (Univ. of Tennessee, Memphis). Biochim. Biophys. Acta, 91: 658-60(Dec. 16, 1964).

The synthesis of histones was studied by a method that avoids many of the problems encountered in cytochemical studies. Ehrlich ascites tumor cells were exposed to 1250 R of x irradiation, and the specific activities of nuclear histones of dividing and non-dividing cells were determined after the administration of (L-^{14}C) glycine. Male inbred Swiss mice, 2-3 months old, were inoculated intraperitoneally with 0.25 ml of undiluted Ehrlich ascites fluid 9-10 days before harvest. The irradiated animals received 1250 R whole-body x irradiation. The results indicated that histone synthesis in Ehrlich ascites tumor cells proceeds readily when mitosis and DNA synthesis are inhibited by radiation. This is regarded as evidence that histone synthesis is not dependent on active DNA replication or cell division. (P.C.H.)

15053 CHROMATOGRAPHIC COLUMN FRACTIONATION OF A RIBONUCLEIC ACID SUBJECTED TO ULTRAVIOLET IRRADIATION. R. Portocala, L. Popa, and I. Samuel (Academia Republicii Populare Romine, Bucharest). Biochim. Biophys. Acta, 95: 185-8(Jan. 11, 1965).

During a study of the action of uv irradiation on RNA, obtained by phenol extraction from normal mouse brain, a hypochromic effect was observed on the spectroscopic curve of this product. The intensity of this effect varied with the duration of irradiation: usually after 4 min the RNA absorption at 260 mμ was about 70% of the value recorded before irradiation. Column chromatography was used for analyzing the alterations of uv irradiated RNA. RNA exposed to uv irradiation usually had lower absorbancy values than the native RNA. The average recovery from methylated albumin adsorbed on Celite columns of irradiated RNA was 97 ± 1% of the input RNA, which shows that practically all of the RNA was eluted. On the other hand, the absorbancy at 260 mμ of the irradiated RNA eluted from this column was 80 ± 4% of that of the eluted native RNA. Since fractions of the irradiated sample were eluted by identical NaCl molarities to those that eluted native RNA fractions, it was assumed that uv irradiation did not modify the molecular weight of the product studied. (P.C.H.)

15054 THE INFLUENCE OF X-RAY IRRADIATION ON THIAMINE METABOLISM. Kazuo Masuko (Nagoya Univ., Japan). Bitamin, 18: 681-91(1959). (In Japanese)

The effect of x irradiation on thiamine metabolism and its mechanism were studied on albino rats and mice. Whole-body irradiation of a white rat at 800 R caused a decrease of the thiamine content in each organ and increases in the blood and urine after 24 hr. For studying the mechanism, thiamine load experiments and in vitro experiments using mitochondria were made. An inhibition of thiamine phosphorylation was found. In preventing a mouse from the x-ray effect, thiamine propyldisulfide was fairly active, and α-lipoic acid and thiamine diphosphate slightly active. (auth)

15055 DRY MASS DISTRIBUTION CHANGES IN MOUSE BONE MARROW CELL POPULATION DURING THE FIRST 24 HOURS AFTER X-IRRADIATION AS DETERMINED BY INTERFEROMETRY. Hun Lee, Victor Richards, and Maria Maichle (Presbyterian Medical Center, San Francisco). Blood, 25: 299-309(Mar. 1965).

LAF_1 mice were treated with a whole-body dose of 800 R x ray. The dry mass distribution of the femur bone marrow cells was determined at different intervals postirradiation. The nonproliferating cells showed no significant dry mass change, whereas the proliferating cells of the myelocyte series had a steady increase in mean dry mass per cell. Few cells with the maximum dry mass increase survive at the end of 48 hours postirradiation. The dry mass distribution formed characteristic patterns for each postirradiation interval studied as the proliferating cells shifted to higher dry mass values with accompanied increase in cell sizes. (auth)

15056 ERYTHROPOIETIC DEPRESS DUE TO SPLENIC IRRADIATION: EXPERIMENTAL STUDY OF THE DISTANT RADIOLOGICAL EFFECT. P. A. Maurice and A. Jeanrenaud (Hopital Cantonal, Geneva). Brit. J. Haematol., 10: 327-38(July 1964).

Various clinical and experimental observations suggest that after irradiation the spleen releases an inhibitor of mitosis that acts on distant organs, particularly on bone marrow. To confirm this hypothetical distant radiological effect (abscopal effect) and to determine its mechanism the surgically exteriorized spleen of rabbits was irradiated and the subsequent alterations of blood and bone marrow studied. Attempts were also made to demonstrate the humoral factor presumably responsible for this distant radiological effect. A 300-R splenic exposure produced, after 48 hr, a transient reticulocytopenia lasting 24–36 hr. The same exposure of the surgically exteriorized splenic area in animals splenectomized a week before or immediately before irradiation did not elicit significant reticulocytopenia. The innocuousness of splenic area irradiation, which affects both the pancreas and the stomach, suggests that the reticulocyte fall observed after splenic exposure results from the splenic radiolesion. In other experiments, splenic exposure depressed the reticulocyte count from a mean value of 29.75 per thousand to 12.5 per thousand, and also depressed the erythroid series as shown by the 3- and 4-hr mitotic indices. On the other hand, exposure of the splenic area did not modify the reticulocyte count or the bone-marrow erythroid mitotic activity in previously splenectomized animals. It was concluded that reticulocytopenia following splenic irradiation reflects a true, transient, antimitotic effect on bone marrow, and not a peripheral sequestering of reticulocytes. In a third set of experiments to determine at what time after exposure the spleen released a hypothetical antimitotic factor, rabbits were splenectomized at varying intervals after splenic irradiation, and tested for erythropoietic changes. Depression of erythropoiesis (drop of mitotic index and of reticulocyte count) occurred only in those animals where the spleen was left in place for at least two hr after exposure; earlier splenectomy prevented the development of this antimitotic effect. The mitotic depression, occurring in animals splenectomized 3 hr after splenic exposure, equaled the depression observed in nonsplenectomized animals after the same splenic radiolesion, suggesting that 2 to 3 hr after exposure the spleen releases, as a single incident, the whole of an antimitotic factor which acts on remote organs such as bone marrow. (TCO)

15057 ENERGY DISTRIBUTION OF ELECTRONS EJECTED FROM BONE AND LUCITE BY 150-300 kvp X RAYS. H. Matsuzawa, K. Hoshino, T. Inada, and K. Kawashima (National Inst. of Radiological Sciences, Chiba, Japan). Brit. J. Radiol., 38: 131-42(Feb. 1965).

The spectral distributions of electrons ejected from plane slabs of compact human bone and Lucite were measured by a magnetic electron spectrometer at various emerging angles less than 70° for 150-300 kvp x rays. Calculations based on the measurements provided data for the mean energy and the effective range of secondary electrons. The results have a bearing on the problem of the absorbed dose in soft tissue at a bone-tissue interface. (auth)

15058 INFLUENCE OF VARIOUS FACTORS ON UV-SENSITIVITY OF STAPHYLOCOCCUS AUREUS STRAIN 209P. W. T. Dobrzanski (Dept. of Microbiology and Hygiene, School of Medicine, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Biol., 12: 505-12(1964).

Studies were made on the effects of cell starvation, incubation in poor media or in the presence of chloramphenicol (CM) or 8-azaguanine (8-AG), as well as photoreactivation (PR) on the uv radiosensitivity of Staphylococcus aureus strain 209P. It was found that these factors with the exception of PR did not increase the survival of uv irradiated 209P cells and even sometimes lowered it. In experiments on the pre-irradiation treatment on the uv sensitivity of 209P strain it was established that incubation of the cells before exposure in the minimal synthetic medium increased the lethal effect of uv radiation. This effect was much greater when, before uv irradiation, the cells were incubated in the synthetic medium with 8-AG. (P.C.H.)

15059 UV-INDUCTION OF STREPTOMYCIN-, NOVOBIOCIN- AND PENICILLIN-RESISTANCE IN STAPHYLOCOCCUS AUREUS STRAIN 209P. W. T. Dobrzanski (Dept. of Microbiology and Hygiene, School of Medicine, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Biol., 12: 513-20(1964).

Information on the uv induced resistance to antibiotics in staphylococci is reported. Streptomycin added at the beginning of post-irradiation incubation completely blocked the phenotypic expression of induced mutants. The results of experiments in which SM was added after 135 min of incubation showed that, immediately after phenotypic expression, the uv-induced SM-R mutants were resistant to streptomycin; they acquired, however, the ability of multiplication in the presence of the antibiotic somewhat later, after an additional lag lasting about 140 min. In another experiment, about 500 SM-R colonies and about 500 Novo-R colonies obtained from post-irradiation cultures of strain 209P were investigated. All the SM-R colonies were resistant to 500 mCg/ml of SM and a considerable part of the Novo-R colonies were resistant to 5 mCg/ml of Novo. The uv induced resistance to SM and Novo remained unchanged after several transfers of resistant colonies on plates without antibiotic. The effects of uv irradiation on nucleic acid and protein synthesis in Staph. aureus 209P is also discussed. (P.C.H.)

15060 GALL BLADDER FUNCTION IN ACUTE RADIATION SICKNESS. P. K. Klimov (Pavlov Inst. of Physiology, Moscow). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 57: 420-4(Apr. 1964). Translated from Byul. Eksperim. Biol. i Med., 57: 46-9(Apr. 1964).

Studies were made on filling of the gall bladder and the concentration of bile in the viscus in acute radiation sickness in dogs. The dogs were given whole-body radiation in the form of a single exposure to x rays in a dose of 500 R. The results showed disturbance of gall bladder filling and bile concentration were functional and depended on the stage of the disease. Dystonia of the gall bladder (mainly of hypotonic character) and dyskinesia of the bile ducts were also found. Experiments in which adrenalin, carbachol, chlorpromazine, and atropine were given showed that the disorganization of the natural synergism of the sympathetic and parasympathetic divisions of the autonomic nervous system creates a roentgenological picture of functional disturbances of the biliary apparatus very similar to the disturbance of the activity of the gall bladder and bile ducts in acute radiation sickness. This suggests that an important factor in the mechanism of the development of the disturbances of the function of the biliary system in acute radiation sickness may be a disturbance of its neuro-humoral regulation. (P.C.H.)

15061 THE EFFECT OF IONIZING RADIATION ON THE EMBRYO AND THE FETUS. J. Lefebvre. Bull. Schweiz. Akad. Med. Wiss., 20: 370-8(1964). (In French)

The results of various animal experiments demonstrating the possible risk to the fetus and embryo incurred by accidental or medical irradiation are discussed. Both malformation and miscarriage occur in direct proportion to the stage of pregnancy, the incidence being over 50% within the first two months and decreasing to 11% between six and ten months. The malformations caused death in ~ one-third of the cases. The possibility of employing x rays for therapeutic abortion was at one time considered, but since there is always the risk of a malformed embryo remaining alive this approach has been discarded. Heterochromia iridis was observed in 23 of 1254 of the infants examined whose mothers had been treated by irradiation during pregnancy, while only two cases were observed of 2276 unexposed infants. Maximum frequency was observed in the infants exposed to irradiation from the 4th to 6th month of embryonic development. Results of experiments on rats are given to corroborate these findings. (TCO)

15062 ENVIRONMENTAL CARCINOGENESIS. Lester Breslow (Public Health Service, Berkeley, Calif.). Calif. Med., 101: 371-5(Nov. 1964).

Environmental carcinogenesis is examined from the standpoints of: universal exposure, as in the case of sunlight or atmospheric pollution; selective exposure of groups of persons, such as those engaged in certain occupations; and personal exposure, for example, to cigarettes. Atmospheric pollution by radioactive materials is cited as an example of exposure of entire populations to a carcinogenic agent. In this case the population of the entire world has been exposed to fallout contamination of the atmosphere. The fallout of radioactive debris from atomic weapons testing has already reached the point where official acknowledgment is given to the production of cancer by this means, including estimates of the amount of leukemia and bone cancer in the U. S. population as well as that of the rest of the world. It is suggested that statements, to the effect that the average dose is low, or similar to background radiation, or various schemes for setting allowable limits or guides, should not obscure the evidence that any amount of radiation may induce leukemia or bone cancer. In addition to radioactive debris, other atmospheric pollutants which may carry a cancer hazard are considered, as well as selective exposure of groups of persons to radiation and other carcinogens. Some examples of exposure to carcinogens inherent in particular work situations cited are: bone sarcoma among watch-dial painters, lung cancer among chromate-ore workers, and cancer of the skin and scrotum among workers exposed to fractions of petroleum. (TCO)

15063 THE EFFECT OF X-IRRADIATION ON THE METABOLISM OF RIBONUCLEIC ACID IN THE NUCLEIC OF THYMOCYTES AND EHRLICH ASCITES CARCINOMA CELLS. J. F. Scaife (Defence Research Board, Ottawa). Can. J. Biochem., 43: 119-22(Jan. 1965). (DCBRL-443)

Work is reported on RNA metabolism in irradiated thymocytes with special reference to the rapidly labeled RNA II fraction of the nucleolus. Parallel investigations were carried out with Ehrlich ascites carcinoma cells to compare a nonsensitive cell with the sensitive thymocyte so as to determine whether mitotic delay occurring in these cells could be correlated with changes in RNA metabolism. X-irradiation affected the RNA II fraction of thymocyte nucleoli 3 to 4 hrs after irradiation, at which time an appreciable number of the cells showed morphological degeneration. No effects were noticed in Ehrlich ascites cells that could account for observed cytological effects. It was concluded that the cytological effects produced by 800 rads of x rays on thymocytes or Ehrlich ascites cells was unlikely due to any primary effect on the biosynthesis of RNA in these cells. (H.M.G.)

15064 PSYCHOLOGICAL EFFECTS OF THE ATOMIC BOMB IN HIROSHIMA: THE THEME OF DEATH. Robert Jay Lifton (Yale Univ., New Haven). Daedalus, 92: 462-97 (Summer 1963).

Much research has already been done concerning the physical consequences of the Hiroshima and Nagasaki disasters, particularly in relation to delayed radiation effects, but little on psychological and social elements. Individual interviews were conducted with two groups of atomic bomb survivors: 33 chosen at random from the more than 90,000 survivors listed at the Hiroshima University Research Institute for Nuclear Medicine and Biology; and 42 other prominent survivors. At the moment the Hiroshima bomb fell, most people were in a relaxed state since, following a brief air-raid warning, the all-clear had just been sounded. People had a false sense of immediate security, as well as a total incapacity to imagine the nature of the weapon that was about to explode. The most striking psychological response was the sense of a sudden and absolute shift from normal existence to an overwhelming encounter with death. Soon there occurred what is termed psychological closure, i.e., people simply ceased to feel; this closure then merged into longer-term feelings of depression and despair. Three rumors circulated widely in Hiroshima just after the bombing: (1) that the city would be uninhabitable for 75 years because of deadly and protracted radiocontamination; (2) that it would be unable to sustain revegetation of any kind; and (3) that all those exposed to the bomb would be dead within three years. This last rumor was directly related to the appearance of frightening symptons of toxic radiation effects. These symptoms and the fatalities that followed aroused a special terror, an image of a weapon which not only kills and destroys on a colossal scale but also leaves behind in the bodies of those exposed to it deadly influences which may emerge at any time and strike down their victims. Survivors were affected not only by the fact of people dying but by the agonizing way in which they died, a gruesome form of rapid body deterioration which seemed unrelated to usual forms of death. During the following years, the fears became magnified by the growing awareness of medical studies demonstrating an abnormally high rate of leukemia among survivors, the increased incidence being first noted in 1948 and reaching a peak between 1950 and 1952 and being greatest in those exposed closest to the hypocenter. For those within 1000 m the increase has been between ten and 50 times the normal. Since 1952 the rate has diminished but is still higher than in nonexposed populations. Survivors are also aware of possible genetic effects of the bomb and express fear about possible harmful effects upon subsequent generations. This is a serious emotional concern particularly in an East Asian culture which stresses family lineage and the continuity of generations as man's central purpose in life and his means of achieving immortality. Actually, systematic studies of congenital abnormalities have so far revealed no higher incidence in survivors' offsping than in those of control populations. However, disturbances in sex ratio of offspring were found: men exposed to a significant degree of radiation have relatively fewer daughters, while exposed women tend to have fewer sons, because of presumed sex-linked lethal mutations involving the X chromosome. Other concerns are from a definite increase in cataracts and related eye conditions, as well as various forms of cancer. Since 1957, laws have created comprehensive medical coverage for survivors which have in some instances encouraged the development in survivors of hypochondriasis, general weakness, and dependency, or what is called "A-bomb neurosis." Maximum medical and economic benefits, however, can be obtained only by those certified to have illnesses specifically related to the bomb. Some critics say the laws are insufficiently comprehensive, others that they foster preoccupation with bomb effects. The survivors, in general, resent the fact that they are considered a separate class of human beings. Although the usual emotional patterns of disaster sequelae are present in the survivors of the bomb, they exceed those of ordinary disasters, the three most important being: (1) the continuous encounter with death, its turbulent onset, its shocking reappearance with delayed radiation effects, and its prolonged expression; (2) a vast breakdown of faith in the larger human matrix supporting each individual life and therefore a loss of faith in the structure of existence; and (3) psychological closure, a distinct pattern of response to overwhelmingly threatening stimuli. It is concluded that, owing to feelings of shame and guilt evident in survivors, they need a new identity in order to come to terms with the postdisaster world. (BBB)

15065 THYROID CANCER DEVELOPING AFTER IRRADIATION OF THE ADULT. J. F. Hynes (St. Francis Hospital, Wilmington, Del.). Delaware Med. J., 36: No. 6, 124-5(1964).

A patient treated in 1948 for Hodgkin's disease of neck and mediastinum at age 15 developed multiple adenomata and a small focus of papillary carcinoma in the thyroid 10 years later. Each lobe of the thyroid probably received 1,500 R within 3 months. Following left total and right subtotal thyroidectomy he remains well, 15 yr since irradiation for Hodgkin's disease and 5 yr since the thyroid cancer was found. (Excerpta med; Vol. 1: No. 12, Dec. 1964)

15066 CONTRIBUTION TO THE PROBLEM OF X-RAY SARCOMA. A. Maggiora, E. Bujard, and W. Jadassohn (Universitat, Geneva). Derm. Wochschr., 147: 209-15 (Mar. 2, 1963). (In German)

Sarcomas resulting from x irradiation of lupus vulgaris do not occur frequently, even if pseudosarcomatous spindle

cell carcinomas are also taken into account. A case is described in which a woman was treated in 1925-30 with an unspecified amount of x radiation and Ra for lupus vulgaris that had existed since 1901. A polymorphic sarcoma of the face was detected in 1960. The tumor was irradiated daily for 32 days with a total dose of 4050 R of x ray. The tumor regressed, and the treatments were discontinued. However, 10 weeks later the tumor recurred. Although daily treatments amounting to 30 R each were reinstituted for a period of 106 days, the tumor disseminated and the patient died. At autopsy histological studies demonstrated sarcomatous metastases in the regional lymph nodes, and in the lungs. The results of the histological studies were compared with findings that resulted from daily x irradiation of guinea pig skin at dosages of 100 or 200 R. In these experimental studies sarcomatous degeneration and spindle cell sarcoma were observed after almost one half year of irradiation. (BBB)

15067 THE DEVELOPMENTAL AUTONOMY OF EXTRA SEX COMBS IN DROSOPHILA MELANOGASTER. Chiyoko Tokunaga and Curt Stern (Univ. of California, Berkeley). Develop. Biol., 11: 50-81(Jan. 1965).

In male flies the first legs possess a sex comb, tibial transverse rows of bristles, and basitarsal transverse rows. These structures are absent on the second and third legs. The recessive autosomal mutant esc (extra sex comb) transforms certain features of the second and third into those of first legs. In different legs the transformation may be incomplete. The different parts may be transformed independently of each other, resulting in an array of partially transformed legs which are epigenetic mosaics of changed and unchanged areas. Genetic mosaics consisting of esc/esc patches on esc/+ legs were obtained in consequence of x-ray induced somatic crossing over. The age of larvae during irradiation varied from 27 to 120 hr. The x-ray dosage varied from 700 R to 2400 R with a dose rate of about 80 r/min, the youngest larvae receiving the lower dosages. Some prepupae aged 120 to 130 hr were also irradiated, with from 2100 R to 2400 R. By a translocation the esc/esc areas were marked by genetically yellow pigmentation on the background of wild-type esc/+. In the genetic mosaics esc acts autonomously in causing the appearance of sex combs and both types of tranverse rows even in very small esc/esc areas. Wild-type colored sex comb teeth on second and third legs were induced by x irradiation of esc/+ males. The second legs of males with the combination $esc^{D}en/+en$ of esc^{D}, a dominant allele of esc, and en (engrailed) had a typical (primary) sex comb as well as the secondary comb normally placed by en on the first leg only. The gene esc as compared to esc^{+} controls the terminal pattern of leg differentiation by changing the competence of imaginal disk cells to respond to a prepattern that is alike for both alleles. The changed response consists in a tendency in certain areas toward growth in a transverse direction coupled with differentiation in a closely packed row, of bristles or teeth. (BBB)

15068 THE DEVELOPMENT OF MITOTIC DISRUPTION IN TRADESCANTIA PALUDOSA MICROSPORES UNDER THE INFLUENCE OF DIFFERENT FLIGHT DURATION ON VOSTOK-5. N. L. Delone, V. F. Bykovskii, and V. V. Antipov. Dokl. Akad. Nauk SSSR, 159: 439-41(Nov. 11, 1964). (In Russian)

Microspores of Tradescantia paludosa were fixed at intervals of 1.5, 76, and 120 hr after the launching of Vostok-5 and at 3.5 hr following its landing. Five types of mitotic aberration (similar to the previous five types registered during the Vostok-4 flight) were noted. In type I, the nucleus remained at the periphery of the cell during prophase, followed by chromosomal nondisjunction during the subsequent mitotic phases. In type II, during prophase the nucleus migrated towards the center of the cell, followed by a rosette formation during metaphase and by nondisjunction. In type III, the spindle orientation in the test spores differed from that in the controls. In type IV, chromosomal nondisjunction and extended telophase occurred. In type V, multipolar mitoses occurred. The aberrations described did not occur exclusively in any given group of spores but rather were evenly distributed throughout the test groups. (OTS)

15069 THE DEPENDENCE OF CHROMOSOME ABERRATION YIELD ON THE DOSE AND INTENSITY OF GAMMA IRRADIATION OF SEEDS. N. I. Nuzhdin and K. A. Fileev. Dokl. Akad. Nauk SSSR, 159: 1151-3(Dec. 11, 1964). (In Russian)

The yield of chromosome aberrations in gamma irradiated (^{60}Co) barley seeds increased linearly with increasing total dose from 1 to 18 kR at all dose rates studied (16 to 253 R/min). The final percentages were also higher, the higher the rate. The percentages of chromosome bridges for a given total dose did not change greatly with increasing rate, but the percentage of fragments increased. (IIC-MG)

15070 STUDIES OF THE SERUM PROTEIN OF SUBJECTS EXPOSED TO IONIZING RADIATION WHILE WORKING. Istvan Lovanyi, Tibor Predmerszky, and Miklos Timar. Egeszsegtudomany, 8: 168-72(1964). (In Hungarian)

The serum protein and mucoprotein levels of 73 workers exposed to ionizing radiation, and of 50 control persons, were determined. The alpha-1 globulin level was generally higher and high mucoprotein levels were more common, in the exposed persons than in the controls. The results can not be regarded as pathological symptoms, but as initial manifestations of the effects of irradiation. (auth)

15071 LATE RADIONECROSIS OF THE BRAIN AFTER COBALT TREATMENT OF THE HYPOPHYSIS, SIMULATING A SPACE-OCCUPYING PROCESS. A. Bignami, R. Giuffre, and A. Riccio (Universita, Rome). European Congr. Neurol. Surg., 2nd, Rome, Article 113, 3p.(Apr. 18-20, 1963).

Clinical and histopathologic data are reported on brain injury resulting from ^{60}Co γ irradiation of the pituitary in the treatment of acromegaly. A woman was subjected to ^{60}Co treatment of the hypophysis and of the epipharynx, with applications in the right and left lateral fields up to a total dose of 5000 rad per field. Eight months after this treatment the patient lost much weight (20 kg in 4 months) and 6 months later there was rapid loss of sight with initial characteristics of bitemporal hemianopsia. Surgical exploration of the area revealed a fixed chiasma, double the normal size, with no process pressing on it. On both sides and above it there was much scar-like tissue coming from the hypothalamus. Post-mortem examination revealed a very small, fibrotic hypophysis, with no enlargement of the sella turcia. Histological examination showed a large zone of recent necrosis, containing much cellular detritus in the central part of the chiasma with intense inflammation of the surrounding tissues. Clinical and histological findings indicate a diagnosis of late radionecrosis of the brain, and the hypothesis is proposed that it should be regarded as an allergic reaction due to the alterations of the nervous tissue brought about by the irradiation. (TCO)

15072 IRRADIATION-INDUCED NEOPLASTIC AND GIANT CELLS IN EARTHWORMS. R. L. Hancock. Experientia, 21: 33-4(1965).

Worms that were x irradiated at 1000 R 23 days before sacrifice time developed masses with typical myoblastoma cells. The granular cells contained acidophilic material. Some of the cells had large vesicular nuclei and others possessed the small hyperchromatic nuclei. The striated muscle tissue had been lost. Sections through the seminal vesicals from a worm fixed 12 days after receiving 1000 R of x irradiation showed myoblastoma cells proliferating around the calciferous gland and eroding the dorsal muscle layers to the exterior. A worm that had received only 100 R and was sectioned 23 days afterwards showed myoblastoma cells, that had invaded the coelum and were seen in the lateral muscle tissues. Giant nuclei were also found in the myoblastoma like masses in the altered areas of the seminal vesicles. (P.C.H.)

15073 CELL STAGES REFRACTORY TO THYMIDINE INCORPORATION INDUCED BY X-RAYS. R. A. McGrath, W. M. Leach, and J. G. Carlson (Oak Ridge National Lab., Tenn. and Univ. of Tennessee, Knoxville). Exptl. Cell Res., 37: 39-44(Jan. 1965).

Autoradiographic studies showed that grasshopper neuroblasts, trapped in mid-mitotic stages by colchicine and then exposed to 64 to 75,000 R of x rays do not incorporate ^{3}HTdR or its derivatives into DNA. The intracellular pool of TdR derivatives is not detectably changed by exposure to x rays. The data showed a correlation between radioinduced incorporation of ^{3}HTdR derivatives and cell stage at the time of irradiation. It is suggested that the synthesis-like condition, during which x-ray-induced incorporation of DNA precursors can occur, degenerates gradually after cells stop normal synthesis of DNA. (auth)

15074 MULTIPOLAR MITOSIS IN THE KB (EAGLE) HUMAN CELL LINE AND ITS INCREASED FREQUENCY AS A FUNCTION OF 250 kv X-IRRADIATION. R. H. Fetner and E. D. Porter (Georgia Inst. of Tech., Atlanta). Exptl. Cell Res., 37: 429-39(Feb. 1965).

The frequency of multipolar anaphases in the KB human cell line were found to be 0.038 ± 0.007 when studied over a period of 14 months. Multipolarity was about evenly divided between tripolar divisions and tetrapolar divisions with a much smaller frequency of cells observed with greater polarity. Irradiation with 250 kv x rays increased the frequency of multipolarity observed. A high positive linear correlation was found between the maximum frequency of induced multipolarity and radiation dose. About 400 R would produce 50% multipolarity and 100% multipolar divisions would theoretically result from 800 R. If the survival curve (dipolar cells) is considered an exponential function of radiation dose, then the mean lethal dose would be about 590 R. The data indicate that radioinduced multipolarity is the result of damage to a sensitive volume (target). The dose required to double the background frequency of multipolarity suggests this primary target has approximately the same sensitivity (or size accounding to the target theory of Lea) as gene mutations. A single functionally double centriole does not appear to satisfy the requirements for the target, because there was neither a sequential appearance of tripolar and tetrapolar spindles after irradiation nor was there a differential frequency of occurrence between the two kinds of multipolarity. (auth)

15075 SOME PECULIARITIES COMMON TO THE EFFECT OF HEXOBARBITAL ON THE X-RAY TREATED FETUSES. N. A. Kalinina (Inst. of Experimental Medicine, Leningrad). Farmakol. i Toksikol., 27: 359-62(1964). (In Russian)

The effects produced by hexobarbital on the condition of respiratory centers and upon the motor reaction to a skin irritation in irradiated and non-irradiated rat fetuses were investigated. The results demonstrated that hexobarbital causes an inhibition of respiratory centers and of the unconditioned reflex activity in fetuses of non-irradiated animals during ultimate terms of pregnancy only. The depressant influence of hexobarbital on the fetuses of irradiated animals was also observed only with its administration in the concluding days of gestation. It should be noted in this conjunction that in irradiated fetuses the reflex activity was depressed to a greater extent than in the non-irradiated ones. (auth)

15076 EFFECT OF X-RAYS ON THE INHIBITION OF PROMOTING ACTION OF THE HOMOGENATE OF REGENERATION BLASTEMAS. J. Semkowicz (Dept. of Biology and Embryology, Medical Academy, Krakow). Folia Biol. (Prague), 12: 383-414(1964).

The effects of different doses of x rays on the action of the homogenate of regeneration blastemas promoting the regeneration of organs in amphibians was studied. Irradiation with x rays at doses ranging from 500 to 7000 R suppressed the promoting action of the homogenate. No recurrence of the regeneration-promoting action was observed in the 5-week period when the taking of biometric measurements was possible. Irradiation of the homogenate with the above-mentioned doses not only cancelled its promoting action but also visibly lowered the rate of regeneration in animals that received this homogenate, as compared with the normal course of this process in control animals. The dependence of the biological effect on the size of the dose applied, reflected by the slowing down of regeneration, was not in the nature of direct porportionality. The inhibitory effect increased with the dose up to 1000 R, but no increase in the biological effect was observed for larger doses. Definitive conclusions could not be made on the composition of promoting substances contained in the homogenate of regeneration blastemas. (P.C.H.)

15077 ON THE CHANGES IN SERUM GLUTAMIC-OXALACETIC AND GLUTAMIC-PYRUVIC TRANSAMINASES AND ALDOLASE OF RATS SUBJECTED TO IONIZING RADIATIONS. I. Andri and M. Caprotti (Universita, Pavia, Italy). Folia Med. (Naples), 46: 67-71 (Jan. 1963). (In Italian)

Thirty-nine adult Sprague Dawley rats, divided into three groups, were used, two groups receiving whole-body irradiation with a total dose of 600 R of 230-kv x rays. The first group was sacrificed three hr after irradiation, the second group after 24 hr, and the third was kept as control. For measuring the glutamic-oxalacetic and glutamic-pyruvic transaminase activities the colorimetric method of Reitman and Frankel was used. Aldolase activity was measured according to the Sibley and Lehninger method. An increase in serum glutamic-oxalacetic transaminase activity was observed three hr after irradiation, and after the 24th hr the activity returned to within the limits of the norm. An increase in serum glutamic-pyruvic transaminase activity was also observed after three hr, and the increased enzyme activity was still present after 24 hr. A net increase was observed in serum aldolase activity, and the values returned to within the limits of the norm after 24 hr. An opposite effect was observed in the mitochondrial enzymatic activity. This suggests that irradiation produces a transient increase in membrane permeability causing an increase of the serum enzymatic activity and concomitant decrease of activity intracellularly. (BBB)

15078 ELECTRON MICROSCOPIC INVESTIGATION OF BRAIN CHANGES OF GUINEA PIGS AFTER X-RAY IRRADIATION. H. Franke and W. Lierse (Universitat, Hamburg). Fortschr. Gebiete Rontgenstrahlen Nuklearmed., 102: 78-87(Jan. 1965). (In German)

The effects of irradiation (200 kv) on the cerebral cortex of 26 male and female guinea pigs were studied. Single doses of 100, 500, 1000, and 2000 R were given. The period of observation was from one hour to 14 days after irradiation. One hour after 100 and 500 R there was increased cytoplasmic permeability. Later swelling of astrocytes and damage to ganglion cells (chromatolysis and nuclear changes) were observed. The interval for this was reduced with increasing radiation dose. (auth)

15079 ON THE INFLUENCE OF IONIZING RADIATION ON THE GENETIC VARIANCE IN HEXAPLOID AND TETRAPLOID WHEATS. D. L. Palenzona (Universita, Pavia, Italy). Genet. Agrar., 18: 195-202(1964). (In Italian)

A comparison of the increase of genetic variance following x irradiation in hexaploid and tetraploid wheat showed that for some characters variability increases in hexaploid more than in tetraploid, whereas for other traits the tetraploid showed more sensitivity to the effect of radiations. The diploidization hypothesis holds true basically with the results. However, the effects of evolutionary factors, which should have contributed to establishing the above two groups of phenotypic traits, seem not to be in agreement with the fact that fitness traits were found in both groups. (auth)

15080 THE NATURE OF INDUCED EXCHANGES BETWEEN THE ATTACHED-X AND Y CHROMOSOMES IN DROSOPHILA MELANOGASTER FEMALES. John C. Lucchesi (Univ. of Oregon, Eugene). Genetics, 51: 209-16(Feb. 1965).

Evidence has been presented that x-ray induced exchanges between an attached-X and marked Y chromosomes are not translocations but are influenced by the homologies existing between these two chromosomes and are probably the result of crossing over. This evidence

was based on a comparison of the distribution of breaks on Y^L when this arm is involved in an exchange with the attached-X and when it is involved in translocations and gross deletions. More critical evidence was obtained by comparing the relative proportion of exchanges involving Y^S (40 percent of all detachments) with the relative proportion of translocations and gross deletions involving the same arm (16 percent of all Y fragments). (auth)

15081 GENETICAL AND BIOCHEMICAL STUDIES OF HISTIDINE-REQUIRING MUTANTS OF NEUROSPORA CRASSA. III. CORRESPONDENCE BETWEEN BIOCHEMICAL CHARACTERISTICS AND COMPLEMENTATION MAP POSITION OF hist-3 MUTANTS. Brooke B. Webber (Oak Ridge National Lab., Tenn.). Genetics, 51: 263-73 (Feb. 1965).

Sixty-eight hist-3 mutants were tested in all possible combinations of pairs in prolonged heterokaryon tests for interallelic complementation. The interaction matrix defines a complementation map consisting of 14 complementation units (complons), with all mutants represented as continuous straight lines. Tests for histidinol accumulation and for in vitro histidinol dehydrogenase activity show the following correlations: subgroup 1 mutants (deficient for histidinol dehydrogenase) are all located in complons 9 through 14; subgroup 2 mutants (deficient for one or two early reactions in histidine biosynthesis) are located in complons 1 through 8; and subgroup 3 mutants (deficient for histidinol dehydrogenase as well as one or two early reactions) cover at least complons 9 through 14 and typically extend into the other half of the map. Mutants with nonpolarized complementation patterns can be separated into three classes on the basis of the type of heterokaryon response, with tests within classes being slower than interclass tests. One line of demarcation falls between complons 8 and 9 (separating subgroup 1 mutants from subgroup 2 mutants); the other falls between complons 3 and 4. These three classes of mutants have different biochemical deficiencies. Randomly selected ultraviolet-induced hist-3 mutants were mapped roughly by heterokaryon tests with eight tester strains. Sixty-one percent of these extend into both halves of the map while 46 percent probably are noncomplementary with other hist-3 mutants, suggesting a close physiological relationship among various types of hist-3 mutants. (auth)

15082 GENETICAL AND BIOCHEMICAL STUDIES OF HISTIDINE-REQUIRING MUTANTS OF NEUROSPORA CRASSA. IV. LINKAGE RELATIONSHIPS OF hist-3 MUTANTS. Brooke B. Webber (Oak Ridge National Lab., Tenn.). Genetics, 51: 275-83(Feb. 1965).

Intercrosses of mutants from the three biochemical subgroups of hist-3 mutants were analyzed to determine the correspondence between their characteristic biochemical deficiencies and their positions on the complementation and genetic maps. These crosses demonstrated a striking correspondence between genetic and complementation map positions of mutants with nonpolarized complementation patterns. Subgroup 1 mutants are located in the right side of both maps while subgroup 2 mutants are in the left side of both maps. Subgroup 3 mutants are located among subgroup 2 mutants in the left side of the genetic map. A possible interpretation of these results is that subgroup 3 mutants result from base-pair insertions and deletions while subgroup 2 mutants result from base-pair substitutions. Subgroup 1 would include mutants resulting from both classes of alterations. Contrasting markers at the arg-3 and nic-2 loci were incorporated into the parents and observed in the progeny. The two following different types of distribution of markers occurred. Crosses not involving mutant 1710 showed more than 50 percent parental combinations of markers; reciprocal crosses not involving 1710 failed to yield reciprocal marker combination frequencies, and crosses involving 1710 (a mutant obtained in a wild-type strain other than 74A) usually exhibited more than 50 percent nonparental combinations of markers and good reciprocity in most pairs of reciprocal crosses. (auth)

15083 GENETIC AND BIOCHEMICAL STUDIES ON ISOLEUCINE AND VALINE REQUIRING MUTANTS OF ESCHERICHIA COLI. K. Kiritani, T. Matsuno, and Y. Ikeda (Tokyo Univ.). Genetics, 51: 341-9(Mar. 1965).

Sixteen isoleucine-valine and two isoleucine-requiring mutants were induced by the treatment of the methionine-requiring mutant strain W2252 of Escherichia coli K-12 with ultraviolet light, X rays, or 2,6-diaminopurine. The mutants were partially characterized biochemically and genetically. With regard to the isoleucine-valine requiring mutants, group Ia mutants were reductoisomerase-deficient and group II strains dehydrase-deficient. The mutational sites of each group were clustered in a region; the two regions were distinctly different from one another, but linked on the chromosome. The mutant strain 101 in the group I cluster possessed a wild-type level of reductoisomerase activity in spite of the apparent block at this step. Mutant strain 115 appeared to possess an extensive multisite or deletion mutation that included the groups I and II. The mutational sites of the isoleucine-requiring mutants were located outside of these two regions. (auth)

15084 ACTINOMYCIN D EFFECTS ON THE FREQUENCY OF RADIATION-INDUCED MUTATIONS IN DROSOPHILA. Ramen Mukherjee (Univ. of British Columbia, Vancouver, Can.). Genetics 51: 363-7(Mar. 1965).

Oregon-R males of Drosophila melanogaster were subjected to the following treatments: actinomycin D + 600 Rads of gamma rays; 0.7N NaCl + 600 Rads of gamma rays; actinomycin D; and 0.7N NaCl. Each treated male was tested for radioinduced sex-linked recessive lethal mutations by the Muller-5 technique, for eight successive daily broods. The actinomycin D + gamma ray series showed a significant reduction in mutation frequency relative to the frequencies in the saline + gamma ray series in all the sperm samples from the third- to the sixth-day brood. The data are consistent with the model of a protein dependent process of mutation fixation of radioinduced premutational genetic damage. (auth)

15085 THE MUTABILITY OF MATURE SPERM OF DROSOPHILA MELANOGASTER IRRADIATED IN THE FEMALE AND IN THE MALE. G. Lefevre, Jr. (Harvard Univ., Cambridge, Mass.). Genetics, 51: 381-90(Mar. 1965).

The mutability of fully mature, motile sperm of Drosophila melanogaster was examined following comparable 4000 R irradiations of inseminated females and adult males. The frequency of sex-linked recessive lethal mutations induced in mature sperm irradiated in the female was found to be affected neither by the age of the male that provided the sperm not by the length of time that the sperm had been mature before being utilized by the male. Thus, mature sperm, once in the female, exhibit a constant mutability. The mutation frequency observed following the exposure of inseminated females was significantly lower than the mutation frequency characteristic of sperm samples derived from the first mating after irradiation of 3- or 7-day-old males. The difference in the detected frequency of mutations induced in mature sperm under the two conditions of irradiation may be related to the fact that, when inseminated females are irradiated, both genomes of the F_1 progeny are exposed; whereas, only the paternal genome is exposed when adult males are irradiated. (auth)

15086 MARKER STIMULATION OF CROSSING OVER: A TEST OF THE THEORY YIELDING NEGATIVE RESULTS AND USING rII MUTANTS OF PHAGE T4. C. E. Folsome (Univ. of Hawaii, Honolulu). Genetics, 51: 391-8(Mar. 1965).

An array of eight rII sites of cistron B of phage T4 were mapped by two-factor crosses. Twenty-one mutants occupying these eight sites were individualized by their reversion-induced profile and assigned to single base-pair addition or deletion, transition or transversion classes. Biparental three-factor crosses involving all

mutants were performed. High negative interference was observed regardless of the mutational type of each mutant. It was concluded that the general theory of marker stimulation of crossing over and its special case of formation of recombinants by internal suppression is insufficient as a mechanism to account for high negative interference. (auth)

15087 GENETIC RECOMBINATION IN DNA-INDUCED TRANSFORMATION OF PNEUMOCOCCUS. I. THE PROBLEM OF RELATIVE EFFICIENCY OF TRANSFORMING FACTORS. Harriett Ephrussi-Taylor, A. Michel Sicard, and Robert Kamen (Western Reserve Univ., Cleveland). Genetics, 51: 455-75(Mar. 1965).

The consequences for biological activity of damaging transforming DNA in vitro were examined, studying effects on mutant and wild-type alleles at the same site, and at different sites representing the two efficiency classes. Subcritical heat inactivation (depurinization) affected identically all marker genes tested, be they at high or low efficiency sites, mutant or wild-type. The one multisite mutant thus far found, r30, was inactivated by depurinization at the same rate as two recombining alleles it covered. Doubt was thus cast on subcritical heat inactivation as a sensitive measure of the dimensions of a mutant gene. UV irradiation had a strongly differential effect on mutants of the two efficiency classes: low efficiency genes were far more inactivated by low uv doses than are high efficiency genes. With one exception, uv sensitivity was found to be very similar or identical for mutant and wild-type alleles at a given site. The one exception was mutant r30 which was uv resistant, while its wild-type allele was uv sensitive. This is compatible with r30 being a deletion of a base sequence responsible for both low efficiency and uv sensitivity. This sequence contained two low efficiency sites, 5 and 17. UV sensitivity as well as low efficiency appear, both, to be site specific and caused by the same structural features of the DNA molecule, or of the recombination process. On the basis of the results, several hypotheses are advanced. (P.C.H.)

15088 A RELATIONSHIP BETWEEN SEX RATIO AND PATERNAL AGE IN DROSOPHILA. Armon F. Yanders (Michigan State Univ., East Lansing). Genetics, 51: 481-6(Mar. 1965). (TID-21589)

Drosophila melanogaster males aged 1, 7, or 14 days were mated at 24-hour intervals to pairs of virgin females and transferred to new females at 24-hour intervals for eight mating periods. The sex ratio of their progeny showed a trend toward a greater proportion of females, which was related to the age of the parent male at the time of mating. Irradiation of the males reduced the proportion of their female progeny, but the shift in sex ratio showed the same relationship to paternal age as in the untreated groups. An age-related, nonrandom meiotic segregation of sex chromosomes into functional and nonfunctional sperm provides a satisfactory explanation for these results. (auth)

15089 RADIATION RESPONSE OF SOAKED BARLEY SEEDS. II. RELATION OF RADIOBIOLOGICAL DAMAGE TO SUBSTANCES LOST BY LEACHING. Om P. Kamra, Saroja K. Kamra, R. A. Nilan, and C. F. Konzak (Univ. of Lund, Sweden). Hereditas, 46: 261-73(1960).

Experiments were conducted to determine whether water per se, or chemical and physiological changes induced prior to x irradiation by water during soaking, is responsible for changes in the response of seeds to x rays. Water in which the seeds were soaked was analyzed to determine the nature and amounts of organic and inorganic substances lost from the seeds in an attempt to ascertain whether the biological damage in the seeds is related to the loss of these substances during soaking. Barley (Hordeum vulgare, hulless variety Himalaya CI 620) seeds were soaked for different time intervals (0, 2, 4, 6, 8, 10, 12, 20, and 24 hr) at 20 and 30°C while different gases (nitrogen or oxygen) were continuously bubbled through the water. After soaking, the seeds were quickly dried to a moisture content of ~15% before x irradiation at a rate of 800 R/min. The effects of soaking on radiosensitivity of seeds were measured by height of M_1 seedlings, frequencies of chromosomal aberrations in shoot tips of M_1 seeds, and frequencies of seedling chlorophyll mutation in M_2 populations. Radioinduced damage to M_1 seedling growth, chromosome aberrations in shoot tip cells of M_1 seeds, and M_2 seedling mutations increased with increasing time of seed soaking before irradiation. In addition, the damage increased with the presence of oxygen during soaking and with higher temperature of soaking. Seeds soaked for 20 hr were usually most susceptible to x rays; additional soaking led to some reduction of the seedling damage. As little as 3 hr of seed soaking changed the radioinduced breakage observed in mitotic chromosomes but this was not obvious from seedling height measurements. Soaking by itself did not produce breaks but increased stickiness. A significantly higher mutation frequency was observed for nonirradiated but soaked seeds than for nonsoaked seeds. Soaking and drying back to constant moisture level of 15% appeared to cause a permanent change in the seeds that persisted up to and during x irradiation. Thus, the increased x-ray sensitivity of soaked seeds was not entirely due to indirect effects of water, but in part may be related to the nature and amounts of substances lost by leaching. (TCO)

15090 A NOTE ON INTERCHROMOSOMAL EFFECTS OF TRANSLOCATIONS AND DEFICIENCY ON CROSSING OVER IN DROSOPHILA MELANOGASTER. C. Ramel, E. Goldman, and T. Kjellstroem (Univ. of Stockholm). Hereditas, 52: 171-5(1964).

Interchromosomal effects on crossing over were studied in Drosophila melanogaster with the use of two 2,3-translocations and one deficiency in chromosome 2. The translocations and deficiency were induced by x irradiation of spermatozoa in males. The translocations showed an increased recombination, the net result of which was a relative increase of the map length with 26% for T 7 and with 37% for T 10. The change of crossing over was significant for all the intervals except the first one, y-ec, where T 7 did not show any significant difference versus the control. The pattern of increase seemed rather uniform along the X chromosome. The deficiency data indicate no or, at most, a weak interchromosomal effect on crossing over. Only one interval, ct-v, showed a difference versus the control, reaching a significance at the 5% level. The total map length was not affected to any appreciable extent. (P.C.H.)

15091 EXPERIMENTAL STUDY ON RADIOBIOLOGICAL MECHANISMS. Jun Makidono, Shingo Takanashi, Tsutomu Yoshimoto, Takashi Kai, and Kilchiro Yoshimoto (Makidono Radiology Clinic, Hiroshima). Hiroshima Igaku, 16: 1025-40(1963). (In Japanese)

An hypothesis, having significance for radiotherapy of malignant tumors, is proposed which states that in addition to the primary injury of radiation on cancer cells, these cells are injured by so-called necrohormones released by irradiated tissues. The products released from damaged cells may also elicit autoantibodies which might further enhance body defenses against malignant cells. Data relating to these concepts were obtained by experiments in rabbits. Three experiments were devised to test the release of necrohormones or autoantigens from injured tissues. In the first study, homogenates were prepared of one kidney of rabbits and injected in the same animal. Injury was seen to occur in the remaining kidney and in liver and spleen, as evidence of formation of autoantibodies. Pathologic changes were also induced in the contralateral kidney when one kidney of rabbits was exposed to a local dose of 1800 R of x rays. Similar changes in one kidney were produced when the other kidney was severely burned. The criteria for considering that these experiments demonstrated the development of autoantibodies are discussed, and other evidence that decomposition products of injured tissues can affect normal tissues is included. The implications of these findings for human radiotherapy are also considered. (BBB)

15092 COLEUKEMOGENIC ACTION OF CROTON OIL IN THE DEVELOPMENT OF LEUKEMIA BY X IRRADIATION. Shozo Irino, Tatsuo Sezaki, Koji Ikejiri, Susumu Sota, and Masanori Suzaki (Okayama Univ., Japan). Igaku To Seibutsugaku, 67: 218-23(Oct. 10, 1963). (In Japanese)

Related experiments were conducted using x irradiation as an initiator of leukemia and croton oil as a promoter. Eight experimental groups of 90 RF mice (30 to 40 days old) and a control group of 300 mice were studied. The experimental groups were x irradiated (200 kvp, 15 ma, 33.5 R/min) to doses of 150, 250, 350, and 450 R with and without applications of croton oil on the irradiated dorsal skin for a total of 40 times in 20 weeks. It was found that the radiation dose of 150 R or croton oil alone did not cause a single case of leukemia in mice. In the mice subjected to x irradiation in doses of 150 or 250 R, incidence of leukemia was much higher among the groups that were given croton oil. After 150 R, leukemia incidence was 0 and 37% with and without croton oil application; the corresponding values after 250 R were 25 and 50%. After 350 R, the incidence of leukemia was highest (77%), and the administration of croton oil did not make a significant difference (incidence 69%). After the dose of 450 R, the rate declined. The croton oil apparently promoted the x-ray initiation of leukemia, thus supporting the initiation-promotion theory. (BBB)

15093 EFFECTS OF 2,4-DINITROPHENOL ON THE FREQUENCIES OF X-RAY INDUCED CHROMOSOME ABERRATIONS IN BARLEY. Ichizo Nishiyama and Noriko Ohta (Kyoto Univ.). Ikushugaku Zasshi, 14: 47-53(1964) (In Japanese)

The effects of 2,4-dinitrophenol (DNP) solution on the frequency of chromosome aberrations induced by x rays were investigated using germinating seeds of a two-rowed barley. The seeds pre-soaked for 24 hours were irradiated with 150 ~ 300R and then treated with DNP solution (10^{-4}M) at various times after or before irradiation. Cytological observations were performed on root-tip cells, fixed at 49.5 hours after soaking when many cells were in the anaphase of the first mitotic division. Treatment with DNP only did not induce any chromosomal aberrations, but DNP treatment combined with irradiation increased aberrations effectively. The effects of DNP was independent of the dose of x rays used, and DNP treatment increased, especially, the frequency of fragments. It was concluded that DNP increased the frequency of fragments, preventing the rejoining of broken chromosomes. (P.C.H.)

15094 ON THE INFLUENCE OF CRYSTALLIZATION OF L-LEUCINE IN ROENTGEN IRRADIATION OF HUMAN SERUM. B. Teichmann and R. Huber (Deutsch Akademie der Wissenschaften, Berlin). Intern. J. Radiation Biol., 8: 297-8(1964). (In German)

The effects of x-irradiated serum of healthy blood donors on the crystallization of L-leucine was investigated. The results of the studies carried out with 7 blood donor groups are tabulated and established that the percentage of false positive reactions increase after irradiation of the serum. The intermediate-type reactions (i-type) are incorporated in the evaluation of the false positive correct negative reactions. The occurrence of cancer-positive reactions appears to have its origin in complex unspecific modifications of the serum or individual serum components. (J.S.R.)

15095 CHANGES IN THE CONCENTRATION OF SEROTONIN IN THE BLOOD OF ANIMALS UNDER THE INFLUENCE OF IONIZING IRRADIATION AND DYNAMIC FACTORS OF FLIGHT. V. V. Parin, V. V. Antipov, M. O. Raushenbakh, P. P. Saksonov, V. S. Shashkov, and G. A. Chernov. Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 3-9 (Jan.-Feb. 1965). (In Russian)

The content of serotonin (5-oxytryptamine) in the blood of animals subjected to the action of x rays and vibration and of animals that were in the cosmic flight on the 4th and 5th cosmic ships was studied. The experiments were conducted on mice, rats, guinea pigs, dogs, and monkeys. Analysis of the experimental material obtained showed that under the influence of a complex of cosmic flight factors, as well as under the separate influence of vibration and ionizing irradiation, a decrease of serotonin concentration occurred. Some possible ways and mechanisms of the decrease of serotonin content in the blood of animals influenced by different factors are discussed. (auth)

15096 LIMB DEVELOPMENT IN PRENATALLY IRRADIATED CATTLE, SHEEP, AND SWINE. B. H. Erickson and R. L. Murphree (Univ. of Tennessee, Oak Ridge). J. Animal Sci., 23: 1066-71(Nov. 1964).

To assess the teratogenic influence of ionizing irradiation on the prenatal domestic animal, the effects of a single acute whole-body exposure of γ irradiation on the limb primordia of cattle, sheep, and swine were studied. The dams were subjected to an acute 400 R whole-body exposure of ^{60}Co radiation at a dose rate of 40 R/hr. The dose received by the fetus or midline of the dam was about 50% of the air dose, or 200 R. Limb development in cattle fetuses irradiated during the 27- to 30-day gestation interval was unaffected. All calves irradiated during this period were apparently normal, except some fetuses irradiated at day 27 of gestation which were born tailless. One of the two calves irradiated at the 31st day of gestation and all three calves irradiated at day 32 had abnormalities of the thoracic limbs, characterized by osseous fusion of the humeroradial articulations or elbow joints. One of three animals irradiated at day 32 was afflicted with malformed pelvic limbs. One of two fetuses irradiated at day 34 was born with defective limbs. Sheep fetuses irradiated on days 20 and 21 of gestation exhibited no noticeable defects at birth. At day 22 the articulations of the elbow joints of the thoracic limbs were defective, causing the limbs to project anteriorly. Similarly to the bovine at day 32 of gestation, the thoracic limbs of both lambs irradiated on day 23 of gestation showed ankylosis of the humeroradial articulations. Fetal irradiation at the 25th day of gestation caused defective stifle joints. No limb or other defects were noted in pigs whose dams were exposed to 400 R of γ irradiation during the interval from 15 to 24 days of gestation. These data show that the critical period for the induction of limb abnormalities is of short duration in both the bovine and ovine. Bovine limb sensitivity extends from late in the 31st day of gestation to early in the 34th day, with day 32 and 33 being the critical points. The period of ovine limb-bud sensitivity is less well defined, but day 23 to day 24 is probably the critical stage within an interval of sensitivity that extends from day 22 to day 25 of gestation. Rear limbs were affected only in the latter half of the period of limb sensitivity, suggesting that forelimb development precedes rear-limb development by at least 12 hr in both the bovine and ovine. The prenatal pig is apparently resistant to the teratogenic action of γ radiation. (BBB)

15097 STUDIES ON ULTRAVIOLET IRRADIATION OF CARBOXYPEPTIDASE A. Hideko Fujioka and Kazutomo Imahori (Tokyo Univ.). J. Biochem. (Tokyo), 53: 341-7 (May 1963).

Bovine pancreatic carboxypeptidase A is inactivated by uv rays (2537 Å) and the primary process of inactivation appears to involve modification of aromatic residues in the protein. Further investigation of inactivation of carboxypeptidase A with uv ray was undertaken on the basis of the fact that rapid hydrolysis of the specific substrate and firm binding of specific substrates with inhibitory analogs require the presence of an aromatic or heterocyclic ring in the molecule. Inactivation, loss of amino acid residues, and change in the helical structure of the enzyme following irradiation were determined. Irradiation of carboxypeptidase A was performed at pH 7.5 and at room temperature (15 to 25°C) in the presence of 0.01 to 0.15% Brij 35, a nonionic detergent. The concentrations of the enzyme were 0.4 to 2.7 mg/ml. Brij 35 was added to prevent aggregation of the protein on exposure to uv rays. The rate of inactivation increased with decreasing concentration of the enzyme and Brij 35, and first-order inactivation was observed even to 97% inactivation. Inactivation of the enzyme in the presence of a competitive inhibitor, β-phenylpropionate or D-phenylalanine, to examine if it protects the enzyme against inactivation, was not successful, because both of these two inhibitors were readily destroyed by uv irradiation. Irradiation of carboxypeptidase A at pH 7.5 resulted in changes in the uv absorption spectrum of the enzyme, i.e., increase in absorbancy was observed over the wave-

length region 240 to 400 mμ. After denaturation of carboxypeptidase A with 3M guanidinium chloride, the rate of the increase in absorbancy at 250 mμ is much greater than that observed for the native enzyme, which indicates that the tryptophyl and tyrosyl groups in the denatured enzyme are more susceptible to uv irradiation. The results of amino acid analysis of acid hydrolyzates of native and irradiated carboxypeptidase A indicate that the amino acid composition of the irradiated enzyme possessing 30% of the original activity agrees with that of the native enzyme except for tyrosine; phenylalanine and histidine are not destroyed by the irradiation. Analysis of N-terminal groups on native and irradiated carboxypeptidase A shows a slight cleavage of a peptide bond during irradiation, i.e., the yield of dinitrophenylserine increases after irradiation; thus, the peptide bond between N-terminal asparagine and penultimate serine is partially cleaved on irradiation. β-Phenylpropionate and D-phenylalanine, powerful inhibitors of carboxypeptidase A, were found to behave noncompetitively towards the irradiated enzyme when examined spectrophotometrically or kinetically. It is inferred from this that the aromatic groups which are destroyed on irradiation are also involved in the inhibitor-binding site. (BBB)

15098 EFFECTS OF WHOLE-BODY IRRADIATION ON RAT LIVER MITOCHONDRIA. Gunter F. Bahr and Ulla E. Glas (Armed Forces Inst. of Pathology, Washington, D. C.). J. Cell. Biol., 23: 8A(Nov. 1964).

The dry mass of rat liver mitochondria was related to the size, shape, and nitrogen content of the mitochondria after whole-body irradiation. Young Osborne-Mendel male rats were irradiated with 1000-R doses by a x-ray unit operated at 300 kv. Mitochondria in sectioned liver tissue and in the isolated state were examined at various intervals after irradiation. Dry mass of individual rat liver mitochondria was determined by quantitative electron microscopy. Size distribution of individual areas of cross-sectioned mitochondria was determined by planimetry of electron micrographs where the final magnification was known. From the median area the volume was calculated. The volume was also determined by using a Coulter counter. The nitrogen content per mitochondrion was examined with a micro Kjeldahl apparatus. A parallel increase in volume and dry mass of mitochondria was found, with a max of 130% of the normal value 6 hr after irradiation. After 15 hours the median volume of the mitochondria was almost down to normal again. (BBB)

15099 X-RAY-INDUCED CHANGES IN THE REPLICATION SEQUENCE OF THE BACTERIAL CHROMOSOME. Daniel Billen (Univ. of Texas, Houston). J. Cell. Biol., 23: 10A(Nov. 1964).

The double label method was used to follow the replication of an isotope-labeled portion of chromosomes in vivo. ^{3}H-Thymidine (TdR) was used as the preirradiation label and ^{14}C-5-bromouracil (BU) as a postirradiation density label for CsCl density gradient analysis of DNA. It was shown that at x-ray dose levels which do not grossly affect the rate of early postirradiation DNA synthesis, as measured by the usual methods, an aberrant replication sequence is induced in Escherichia coli strain 15T-(555-7) (requires thymine, arginine, methionine, and tryptophan for growth). Thus doses of 2500 (LD_{37} dose) and 5000 R result in the initiation of additional replication sites on the bacterial chromosome. DNA replicated immediately before irradiation (labeled with ^{3}H-TdR for 5 min) is replicated at once after reincubation in Bu. The unirradiated control requires about one-half the generation time before the ^{3}H-pulsed region begins replication. Intermediate-density DNA, as seen by banding between hybrid (BU replacement in one unit) and normal (containing thymine only in both units) DNA, can be isolated after preparative banding of the DNA from the incubated irradiated cells, but not from the controls. In addition, a portion of the DNA present before irradiation is converted to a nonreplicative form. The results are interpreted as showing that x rays lead to physical changes in the DNA such that new replication points are introduced. These may partly or wholly reflect the induction of segments as a result of strand breakage. The portion of DNA converted to a non-replicative form perhaps reflects the formation of non-reparable intra- or interstrand cross-linking. (BBB)

15100 RADIATION-INDUCED INCORPORATION OF TRITIATED THYMIDINE INTO DNA OF PHYSARUM POLYCEPHALUM. Richard A. McGrath (Oak Ridge National Lab., Tenn.). J. Cell Biol., 23: 58A(Nov. 1964).

Synchronous cultures of this slime mold were incubated in ^{3}H-thymidine, and exposed to 25 kR of x rays. The sp act. of DNA from irradiated cultures was 40% greater than that from nonirradiated preparations. Feulgen spectrophotometric measurements indicated the same amount of DNA per nucleus in both cases. After exposure of samples to uv light, the proportion of thymine to thymine dimers was the same in irradiated and nonirradiated samples, indicating that there had been no large addition of only thymine to DNA. Heating and cooling in 1% formaldehyde did not release any low-molecular-wt pieces that were separable from DNA on Sephadex columns, which argues against loose association of precursor and DNA. The possibilities that specific activity of the precursor pool may be changed by irradiation and that replacement of damaged sites on DNA may occur are offered as possible explanations. (auth)

15101 PERMANENT RECOVERY OF SUPRALETHALLY X-IRRADIATED AMEBAE AFTER THE INJECTION OF SUPRALETHALLY NITROGEN MUSTARD-TREATED AMEBA PROTOPLASM. Edward W. Daniels (Argonne National Lab., Ill.). J. Cell Biol., 23: 115-16A (Nov. 1964).

Cellular damage due to x-irradiation is different from that caused by nitrogen mustard (methyl-bis-(β-chloroethyl)-amine hydrochloride = HN2), as shown by studies on the radiosensitive giant multinucleated ameba Pelomyxa illinoisensis. All of 500 supralethally x-irradiated (30 kR) amebae)) died within 8 days without dividing. Forty similarly x-irradiated amebae were given unirradiated cytoplasm, without nuclei, from stock amebae by microinjection within two days after x-ray exposure; 70% of these amebae recovered permanently and produced cultures of many cells. This shows that the nuclei in the supralethally x-irradiated amebae are not irreversibly damaged, and that cytoplasm of unirradiated amebae has the capacity to prevent radiation-induced death. Each of 200 nonirradiated amebae treated for 1 hr with lethal doses of HN2 (0.1 to 0.2 mg/ml) died without division within 12 days. Similarly treated amebae recovered and divided after injection with nucleated protoplasm from untreated stock amebae, but not after the injection of untreated cytoplasm alone. Thus, the nuclei in lethally HN2-treated P. illinoisensis amebae appear to be irreversibly damaged. Finally, 80% of 72 supralethally x-irradiated amebae recovered permanently after micro injection with supralethally HN2-treated protoplasm which contained nuclei. Preliminary work has subsequently been done with 18 supralethally x-irradiated amebae which received only cytoplasm from lethally HN2-treated amebae. These organisms underwent cell division and their lifetimes were greatly extended. (auth)

15102 ONSET AND DURATION OF DNA SYNTHESIS IN ANTIBODY-FORMING CELLS AFTER ANTIGEN. Edward P. Cohen and David W. Talmage (Univ. of Colorado, Denver). J. Exptl. Med., 121: 125-32(Jan. 1965).

Experiments were designed to determine the onset and duration of DNA synthesis in precursors of antibody-forming cells after a second injection of particulate antigen in the irradiated mouse. Spleen cells were labeled in vitro with T-labeled thymidine at varying times after exposure to antigen in vivo. Antibody-forming cells were identified after transfer to a neutral host by specific fluoroscein stain. DNA synthesized during the earlier in vitro period was detected by autoradiography. The results indicate that with the antigen and species used antibody-forming cells began DNA synthesis within 5 hr after the injection of antigen, and continued for at least 24 hr. By 48 hr, all synthesis of DNA in antibody-forming cells had stopped. No DNA synthetic activity before exposure to antigen was detected. The use of irradiated isologous recipients eliminated participation by the host in the

immune response. This was confirmed in that recipients receiving antigen alone (without donor cells) formed no detectable hemagglutinating antibody nor was it possible to find antibody-containing cells in the spleens of these animals. However, examination of the spleens of irradiated mice that had received an intravenous injection of antigen and cells from a previously immunized donor 2 or 3 days prior to sacrifice revealed frequent cells with antibody. Recipient mice that had received spleen cells alone (without antigen) from previously immunized donors revealed no detectable antibody-containing cells in their spleens. (BBB)

15103 RELATIVE POOL SIZE OF POTENTIALLY COMPETENT ANTIBODY FORMING CELLS OF PRIMED AND NONPRIMED SPLEEN CELLS GROWN IN IN VIVO CULTURE. Eugene H. Perkins and T. Makinodan (Oak Ridge National Lab., Tenn.). J. Immunol., 92: 192-200 (Feb. 1964).

Attempts were made here to confirm that at least two potentially competent (PC) cell compartments exist in sequence. Spleen cells from primed and nonprimed donors were cultured in lethally irradiated, isologous recipients and the relative pool size of PC cells was determined at varying intervals for 13 days under various experimental conditions. The results showed that the pool size of PC cells decreased to a minimum during the first 5 days after culture of nonprimed spleen cells. This decrease in pool size could be circumvented almost completely by the combined treatment of reduced radiation exposure to recipients and bone marrow therapy. It could be accentuated by exposing these cells to a noncross-reacting antigen when spleen cells are known to be proliferating and differentiating into terminal blood cells maximally. In contrast, the pool size of PC cells from primed donors neither increased nor decreased significantly during this period of observation and, furthermore, was not affected by these treatments. The results indicate that there exist, in accordance with the unidirectional flow model, at least two sequential compartments of PC cells, PC_1 and PC_2. Cells in the former compartment can be considered to multipotent (capable of differentiating along several paths depending upon the stimuli) and those in the latter unipotent and therefore insensitive to hematopoietins and unrelated antigenic stimuli. (TCO)

15104 GROWTH AND SENESCENCE OF THE PRIMARY ANTIBODY-FORMING POTENTIAL OF THE SPLEEN. T. Makinodan and William J. Peterson (Oak Ridge National Lab., Tenn.). J. Immunol., 93: 886-96(Dec. 1964).

Growth and senescence of the primary antibody-forming potential (PAFP) of the spleen was assessed by culturing spleen cells of 1- to 126-week-old mice together with the test antigen in heavily x-irradiated, genetically compatible, 12-week-old mice. The maximum growth rate of the PAFP of the spleen occurred during the first month after birth. The mean doubling time during this period was ~4 days in contrast to 14 days for spleen and body weights. The highest antibody-forming activity was obtained with cells from 40-week-old mice. The PAFP of the spleen increased ~600-fold between 1 and 40 weeks of age. In contrast, the body weight increased only 8-fold and the spleen weight 4-fold. After 40 weeks of age the PAFP of the spleen decreased gradually with age. Among the very old mice (~120 weeks) it was only one-fourth that of the spleen of 40-week-old mice. With improvement in the animal health program the PAFP of the spleen increased, especially among the very old mice. Evidence was presented to show that the change in the PAFP of the spleen with age is due mainly to the change in the number of potential antibody-forming cells. Furthermore, it was shown that the change in the number of these cells with age is not due to migration of these cells to and from the spleen. The significance of these results is discussed from the standpoint of functional differentiation. (auth)

15105 THE EFFECT OF X-RAY IRRADIATION UPON THE SEQUENCE OF IMMUNE GLOBULINS FOLLOWING INITIAL IMMUNIZATION IN THE RABBIT. John Robbins and Richard T. Smith (Univ. of Florida, Gainesville). J. Immunol., 93: 1045-52(Dec. 1964).

Experiments were undertaken to examine the effects of x irradiation on the demonstrated sequence of immune globulins following immunization. Sublethal (400 R) and supralethal (1000 R) irradiation in the rabbit did not suppress the immune response uniformly; rather, the appearance of γ_2-globulin antibody was relatively decreased or inhibited completely, as compared to macroglobulin synthesis, which was reduced but not totally inhibited by 1000 R. Shielding immunologically competent cells of the spleen, appendix, blood, or peripheral lymph nodes was effective in suppressing γ_2-globulin synthesis selectively. It was not essential that the shielded cells permit prolonged survival as in the case of appendix and whole blood shielding. This antigen stimulus initiated a normal sequence of antibody synthesis when it was introduced so as to encounter nonirradiated lymphoid tissue, but only macroglobulin synthesis if introduced into an irradiated area. The data might indicate that macroglobulin antibody synthesis is radiation-resistant because it does not require extensive cell differentiation. Conversely, γ_2-globulin synthesis would be radiation sensitive because it requires such differentiation. (TCO)

15106 LACTATE DEHYDROGENASE ISOENZYMES IN THE NERVOUS TISSUE. V. THE EFFECT OF X-RAYS ON THE ENZYME OF THE DEVELOPING AND ADULT RAT BRAIN. Vincenzo Bonavita, Giuseppe Amore, Salvatore Avellone, and Rosa Guarneri (Univ. of Palermo, Italy). J. Neurochem., 12: No. 1, 37-43(Jan. 1965).

New-born and adult rats were submitted to x irradiation (300 to 500 R) to the head, and electrophoretic and catalytic studies were carried out on the brain LDH of these animals and their control littermates. It was found that head irradiation is responsible for an accelerated maturation of the LDH isoenzymic pattern in the developing brain, but not for changes of the isoenzymic composition in the adult animal. Kinetic studies showed that the x-ray treatment of new-born rats is also responsible for a decrease in the affinity of LDH for pyruvate and a late shift toward acidity of the pH optimum for pyruvate reduction. The same decrease of the affinity for pyruvate was also measured with brain LDH of adult animals exposed to x rays. In this instance, however, the early decrease of affinity was followed by a slow return to the control K_m value. The relations between these findings and histopathological changes induced by x rays in neurons and glial cells is discussed. (auth)

15107 EFFECT OF Co^{60} γ-RAY IRRADIATION ON THE DEVELOPMENT AND REPRODUCTIVE POWER OF TROMBICULA AKAMUSHI VAR. DELIENSIS. Ping-k'un Hsu, Chia-ts'an Li, and Hsin-t'ao Ch'en. K'un Ch'ung Hsueh Pao, 12: 578-85(1963).

The effects of irradiation on the development and reproductive power of insects was studied. Larvae of Trombicula akamushi var. deliensis were irradiated with ^{60}Co γ rays at a varying dosage. Tests showed that a dose of 2500 R had a definite effect on development. When the dosage was increased to 20,000 R, none of the nymphs were able to develop to the adult stage. The larger the dosage within a certain limit, the greater was the effect on the reproductive power of adults. Irradiation had a greater effect on unfed individuals than on the same well-fed instars. Irradiation also seemed to exhibit a greater effect on the earlier stage of instar growth. Observations also showed that irradiation had no marked effect on the reproductive power of well-fed Trombicula akamushi var. deliensis in the following treatments: 1st generation larvae with 25 R, 1st and 2nd generation larvae with 100 R, and 1st generation larvae and nymphs with 100 R. Observations were based on the number of larvae hatched from the eggs oviposited by treated insects. It was concluded that irradiation has a greater effect on the reproductive power when applied during the unfed larval stage. (TCO)

15108 RUNT INTESTINAL DISEASE. R. W. Reilly and J. B. Kirsner (Univ. of Chicago). Lab. Invest., 14: 102-7 (Jan. 1965).

A problem not resolved in radiation chimera studies is the effect of the immunologically competent graft vis-a-vis radiation in the production of the intestinal lesions, i.e., do

the grafted lymphoid cells act only by intensifying damage already produced by x ray (perhaps by interfering with mitosis during postirradiation intestinal repair), or is the graft a primary factor which contributes more directly to the over-all pathologic picture? Histologic changes in the small intestine of F_1 mice that received parental strain spleen cell grafts alone or following a small dose of x irradiation (100 R) are described. A distinct pattern of intestinal disease occurred in the runting syndrome. Small doses of irradiation intensify this pathologic picture, quantitatively only. Lack of weight gain, sticky intestinal content, diarrhea, and intestinal pathology of the kind described would seem to indicate malabsorption as a pertinent factor in the immunopathologic, wasting syndrome known as runt disease. (BBB)

15109 RADIATION AND HEALTH. Lancet, 2: 112 (Nov. 21, 1964).

Figures are presented showing morbidity and mortality rates for various diseases in Great Britain and contrasted with the relatively lower rates of radiation accidents and risks. Such a comparison shows that radiation is numerically at present one of the smaller risks in industrial society. The number of deaths and injuries reasonably attributable to radiation is very small, but this does not obviate the necessity to reduce the occupational hazard to a minimum, and to consider the potential dangers of natural and artificial radioactive substances. It is pointed out that the medical profession has not attempted to assess comprehensively either the good or the harm radiation does, which may account for the disregard for the positive contribution to the community of radiation in medical hands. It is suggested that the most important influence of atomic energy and radioactive materials on the health of the world may be through agriculture. For one of the world's real problems, shortage of food and water, atomic energy could probably have its greatest effect in reducing loss in production, storage, and distribution of food, raising the productivity of land, and developing new areas. (TCO)

15110 EXPERIMENTAL PRODUCTION OF PAROTID GLAND ATROPHY BY LIGATION OF STENSEN'S DUCT AND BY IRRADIATION. W. McKenzie Wallenborn, T. Austin Sydnor, Y. T. Hsu, and G. Slaughter Fitz-Hugh (Univ. of Virginia, Charlottesville). Laryngoscope, 74: 644-55 (May 1964).

A comparison was made of the histopathologic changes in the rabbit parotid gland as produced by ligation of Stensen's duct in one series with those produced by x irradiation in another series. The most reliable method of ligating the parotid duct was to make a vertical incision extending from the medial (or anterior) canthus of the eye down to the inferior border of the mandible. A horizontal U-shaped flap was elevated by an incision which began anterior to the external ear and extended forward under the eye to the medial canthus. It then descended vertically through the original incision and again extended posteriorly under the horizontal ramus of the mandible to the angle. The parotid duct was easily identified and excised. The parotid glands of other rabbits were irradiated using conventional x rays from a 200-kv source. Three rabbits were given 500 R, three were given 1000 R, and another three were given 2000 R. The irradiation dosage was given weekly over a one, two, and three-week period respectively. At varying intervals the glands were excised and examined microscopically. In 11 glands of 25 excised within 19 weeks or less, there was predominantly only slight atrophy produced by ligation of the duct as evidenced by nine with slight versus two with marked atrophy. In 14 glands excised from 20 to 62 weeks post-ligation, there was consistently more moderate to marked atrophy. Ten parotid glands which had received from less than 500 to 2000 R were excised from 5 to 77 weeks postirradiation. Microscopic study revealed predominantly marked atrophy in this series, with eight with marked and two with moderate atrophic changes. Irradiation produced the more prompt and more marked atrophy of the two methods. Possible clinical applications of this experimental study are discussed. Irradiation, although more rapid in its effects, has certain drawbacks which require some reservations as to its use in benign conditions. Possible late carcinogenic effects, xerostomia, and secondary radionecrosis must be considered with this form of therapy. Ligation of the parotid duct is a simple and safe procedure to perform and thus is to be recommended as a method for producing parotid atrophy in all age groups. Some of the disease processes which may be treated by this method include chronic recurrent parotitis, parotid fistula, especially those resulting from injury to the duct itself, recurrent parotid calculus formation, and Mikulicz's disease. (BBB)

15111 FAT ABSORPTION TESTS PERFORMED WITH ^{131}I-LABELED TRIOLEIN UNDER NORMAL AND PATHOLOGICAL CONDITIONS. Eva Nagy de J., Laszlo Nyiroe, and Istvan Elekes (MTA Orvosradiologiai Kutatocsoport, Budapest). Magy. Radiol., 16: 259-66(Oct. 1964). (In Hungarian).

Experiments were conducted in humans to determine the normal levels of fat absorption and how ionizing irradiation alters the fat absorption in man and animals. Thirty clinically healthy persons were tested to determine the normal levels of triolein-^{131}I absorption; results were obtained on both whole blood and plasma, as follows: the fat-bound iodine in whole blood after 2 hr was 11.25%; 4 hr, 13.73%; 6 hr, 12.18%; 8 hr, 9.95%; 24 hr, 5.22%; fat-bound iodine in plasma was at 2 hr, 8.11%; 4 hr, 11.33%; 6 hr, 9.48%; 8 hr, 4.82%; 24 hr, 3.11% (as percentage of the injected dose). In 30 women with gynecologic cancer, each receiving an average of 2000 R x irradiation in four pelvic areas, totaling 8000 R (some of these patients had received ^{198}Au intraperitoneally), the results were as follows: triolein-^{131}I in whole blood after 2 hr was 11.78%; 4 hr, 11.26%; 6 hr, 9.51%; in plasma, after 2 hr, 6.97%; 4 hr, 7.51%; 6 hr, 6.07%. Thus fat absorption in the irradiated patients was generally lower than in healthy subjects with no outstanding exceptions. Plasma data were also obtained from surgical patients with gastrointestinal disorders, such as steatorrhea, and the results were as follows: fat absorption as seen by levels were plasma after 30 min, 7.22%, 1 hr, 7.99%, 2 hr, 7.94%, 4 hr, 7.48% of the injected radioactivity. These figures indicate below normal fat absorption in this group. It is pointed out that the lower values obtained from the irradiated patients may not indicate lower fat absorption, but rather alterations in the rate of the fat metabolism, the malignant tumors utilizing a larger amount of the newly absorbed fat. (BBB)

15112 THE ROLE OF BLOOD CATALASE ACTIVITY IN THE RADIATION INJURY OF ERYTHROCYTES. Olga Geszti, Laszlo Sztanyik, Istvan Arki, and Erika Mandi (Magyar Nephadsereg Egeszsegugyi Szolgalata, Budapest). Magy. Radiol., 16: 288-93(Oct. 1964). (In Hungarian)

The role of the postirradiation changes in the activity of blood catalase in the mechanism of radiation injury of erythrocytes was studied. The tests were conducted on 56 rabbits, 18 serving as controls and the rest receiving x irradiation in doses of 470, 940, and 1410 R. Blood samples were taken daily from all animals. Catalase index (CI) in the control group showed an average of 24.21 ± 0.55, but it varied from as low as 10 to as high as 41. The findings of the three groups of irradiated animals showed no significant changes in CI even within such a wide dose range (sublethal, lethal, and supralethal) as that tested, in the early postirradiation period. However, decreased activity was seen in the preterminal period, which was on the 8th and 9th day in the sublethal-dose group, on the 6th and 7th day in the lethal group, and between the 3rd and 6th day in the supralethal group, which may be due to the lack of young cells having high catalase activity as seen by the reticulocytopenia and selective destruction of young erythrocytes. Thus the decreased catalase activity is an effect and not the cause of radiation damage to the erythrocytes. In a second test series, blood samples were taken every 2 to 3 minutes in the first 20 minutes following 940-R x irradiation, and thereafter at 30, 45, 60, and 120 minutes. CI remained within the normal range, varying between 21 and 26 in the first 20 min and stabilizing at 22 thereafter. It is suggested that the x irradiation and the resultant production of H_2O_2 have a damaging effect on erythrocytes. Since increasing amounts of irradiation create increasing amounts of peroxide, greater catalase activity is required

to decompose this substance; this catalase activity is, however, not available because of the injury to the erythrocytes. (BBB)

15113 INHERITANCE OF QUANTITATIVE CHARACTERISTICS AND METHODS FOR INCREASING THE GENETIC MUTABILITY OF POPULATIONS. R. E. Scossiroli (Pavia Università). Magy. Tud. Akad. Biol. Tud. Oszt. Kozlemen., 6: 297-318(1963). (In Hungarian)

Experiments with fruit flies indicated that irradiation of the population results in a faster evolution than is possible with unirradiated groups. Thus, the radioinduced mutability is responsible for the accelerated rate of evolution. The problem of artificial selection was studied on the Drosophila, exposing the first three generations to 3000 R of x radiation. The inheritance of the variation in the growth of the sternopleural hair was used as the indicator. The results showed that exposure to x radiation is an effective tool for creating minor gene mutations which result in additive genetic mutability. This new genetic mutability may be used for artificial selection to improve the desired characteristics of plants and animals. The ionizing radiation helps to overcome the establishment of stable levels in the characteristics. Such tests were carried with economically important plants, such as corn, wheat (T. durum cultivar Cappelli) and tobacco. The tests with corn were carried out on an autodiploid species, resulting from the chromosome doubling of monoploid plants. It was concluded that high exposures, useful for studying the mutation of individual genes, are not suitable for inducing genetic mutability. The optimum irradiation level must be determined separately for each species. (TTT)

15114 SEROLOGIC CONTROL OF PATIENTS TRANSFUSED WITH HOMOLOGOUS BONE MARROW. C. T. Nicolau, Marilena Fotino, and Vlad Apateanu (Centrul de Hematologie. Bucharest). Med. Interna, 15: 1425-33(Dec. 1963). (In Romanian)

For the purpose of developing methods for restoring hematopoietic function by homologous bone marrow transplantation in heavily irradiated or drug-treated cancer patients, immunologic reactions were followed in 20 cases transfused with homologous marrow cells. Both early and late incompatibility reactions, as well as signs of the secondary syndrome, were studied. All 20 investigated patients suffered from pancytopenia, either of an idiopathic type or as a result of treatment with cytostatic drugs. They had all received multiple blood transfusions, and because of corticosteroid treatment were in a state of low immunologic reactivity. Three cases showed evidence of autoimmune hemolytic anemia. Homologous marrow for transfusion was chosen from donors with compatible major blood groups (ABO, MN, Rh), and siblings as donors were used when possible. The three cases with autoimmune hemolytic anemia benefitted from the marrow transfusions, by showing increases in peripheral blood cells and repopulation of bone marrow, after mild post-transfusion reactions (fever, chills). In the other 17 cases which lacked autoantibodies initially, marrow transfusion was not beneficial in raising peripheral cell counts but no new antibodies could be detected in their serums as a result of the infusion. In one patient who was given a second marrow infusion, a hemolytic episode occurred and weak serologic reactions were found as evidence of immunization. It is concluded that the immunologic problems arising as a result of homologous bone marrow transplantation are no different than those developing after blood transfusions. (BBB)

15115 INDIVIDUAL SENSITIVITY OF DOGS TO RADIATION. N. A. Volokhova. Med. Radiol., 9: No. 11, 40-5(Nov. 1964). (In Russian)

Studies were made to relate individual variations in the sensitivity of dogs to identical doses of radiation and their individual compensating reactions to similar doses of physical stress created by exercise on a treadmill and total-body heating in a lamp box. The experiments were conducted on 3 female and 18 male dogs from 1 to 2 years old. Physical stress consisted of a treadmill run at 6 km/hr for 30 min and heating in a lamp box with an ambient air temperature of 45 to 50°C for 1 hr. The functional state of the dogs was followed for 3 to 4 hr following stress by monitoring changes in body temperature, respiration, pulse, total leukocyte count, and peripheral blood. The dogs were exposed to gamma radiation in doses of 300 R (14 dogs) and 250 R (7 dogs). Seven of the 21 dogs survived and 14 died at various periods following irradiation. The coefficient of correlation between length of life and 30-min pulse rates was 0.65, and the correlation between length of life and 1-hr body temperatures was 0.49. The results obtained lead to the conclusion that the degree of radiation injury depends not only on the total absorbed dose, but also on the character of the organism's compensating reactions. The correlation between length of life following irradiation and the functional state as reflected by cardiovascular activity was particularly well confirmed statistically. Leukocyte counts were found to be statistically nonsignificant and were discarded as an index. The thermoregulatory function of the organism was also found to be in correlation with radioresistance. It is known that the higher the skin temperature of dogs immediately following heating, the better the state of their thermoregulatory function. It was found that the animal's radioresistance is directly related to its initial functional state as reflected by the state of the thermoregulatory function. Higher nervous activity was also found to be an indicator of the functional state of the organism and thus of the organism's radioresistance. (TCO)

15116 PROTEIN METABOLISM OF THE LIVER IN ACUTE RADIATION SICKNESS ACCORDING TO HISTOAUTORADIOGRAPHIC DATA. V. A. Revis and V. N. Titov (Kalinin Inst. of Medicine, USSR). Med. Radiol., 9: No. 11, 54-61(Nov. 1964). (In Russian)

Protein metabolism was studied in the liver and kidneys in 58 rabbits during a one-month period following x irradiation in a dose of 1,100 R. In a second series of experiments (60 rabbits) subcutaneous transplantation of the spleen was performed in animals for the purpose of treating acute radiation sickness 48 hours after irradiation. The intensity of the protein metabolism of the liver and kidneys was studied by means of histoautoradiography, with the use of labeled methionine-^{35}S. The results disclosed that total x irradiation leads to a sharp inhibition of the protein metabolism in the liver and kidneys for a prolonged time. A maximal decrease of the intensity of methionine-^{35}S inclusion into liver and kidney proteins occurred from the 2nd to 18th day following irradiation, whereas restoration to the initial level took place on the 24th day in the kidneys and on the 27th day in the liver. Subcutaneous transplantation of the spleen was conducive to restoration of the protein metabolism in the organs in considerably shorter periods. Upon this condition the intensity of methionine inclusion in the liver reached normal values on the 13th day and in the kidneys on the 3th day after irradiation. (auth)

15117 INVESTIGATION OF THE BLOOD COAGULATION SYSTEM IN PATIENTS WITH CANCER OF THE LIP AND SKIN DURING RADIUM THERAPY. L. A. Baronina (Ternopol Medical Inst., USSR). Med. Radiol., 9: No. 12, 3-8(Dec. 1964). (In Russian)

Under study were the indices of the blood coagulation system in patients suffering from cancer of the lip and skin who were treated by means of short-distance x-ray therapy. Short-distance x-ray therapy does not cause changes in the recalcification time, prothrombin indices, thrombin time, free heparin of the blood. Although a decrease in the proaccelerin content and an increase in the blood clot retraction are statistically significant, nontheless they are within the values observed in healthy persons. (auth)

15118 THE FUNCTIONAL STATE OF THE CEREBRAL CORTEX OF RABBITS DURING OPERATIONS ON THE LIVER AFTER IRRADIATION. P. E. Ogii and E. A. Markova (Ternopol Medical Inst., USSR). Med. Radiol., 9: No. 12, 40-6(Dec. 1964). (In Russian)

The results of observations over the features peculiar to reactions of the rabbit cerebral cortex to operative trauma of the liver at an early postirradiation (different doses of x-rays) period are described. The investigations

showed that the effect of ionizing radiation on the organism at an early period changes the reaction of the central nervous system to operative trauma. The nature of these changes depends on the intensity of irradiation. (auth)

15119 THE MECHANISM OF THE PROTECTIVE INFLUENCE OF NIBUPHIN ON THE HEART IN ACUTE RADIATION SICKNESS IN RATS. B. S. Berezovskii and I. V. Zaikonnikova (Kazan Medical Inst., USSR). Med. Radiol., 9: No. 12, 50-2(Dec. 1964). (In Russian)

In experiments on 150 albino rats the protective effect of nibuphin (a phosphosphorganic anticholinesterase preparation) were studied on the heart in radiation sickness. Prophylactic introduction of nibuphin prior to lethal x-ray irradiation distinctly prolonged the term of the animals death during the first three days, noticably reduced the cardiac muscle cholinesterase activity, and preserved an almost normal electric activity of the heart. (auth)

15120 THE RADIORESISTANCE AT DIFFERENT STAGES OF ACUTE RADIATION SICKNESS. I. G. Akoev. Med. Radiol., 9: No. 12, 53-8(Dec. 1964). (In Russian)

In experiments carried out on dogs it is demonstrated that at different stages of acute radiation sickness, the radioresistance of animals practically did not depend on their clinical condition prior to repeated irradiation, but was mainly dependent upon the time lapse after the first irradiation. However, in experiments staged on rats it is shown that five months after irradiation their radioresistance to repeated irradiation depended largely upon the physiological state of the organism, which was altered by the administration of hormonal preparations. (auth)

15121 THE INFLUENCE OF IRRADIATION ON THE VASCULAR PERMEABILITY, MUCOPOLYSACCHARIDE AND SEROTONIN BLOOD LEVEL. G. A. Chernov, Z. I. Sheremet, and R. V. Lenskaya (Central Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol., 9: No. 12, 58-62(Dec. 1964). (In Russian)

The blood serotonin level in dogs and guinea pigs is sharply reduced, while the mucopolysaccharide content is significantly elevated, at the peak of radiation sickness. No strict correlation was found between the dynamics of these indices and alteration of the total vascular permeability during radiation sickness. (auth)

15122 CASTRATION DOSES IN THE RABBIT OVARY. EXPERIMENTAL RESEARCH. PRELIMINARY NOTE. G. Reggiani, G. Pipino, and A. M. Podesta (Universita, Genoa). Minerva Fisioterap., 7: 285-8(Sept.-Oct. 1962). (In Italian)

A telecobalt source of 1300°C with a field of 8 × 12 cm, was used to irradiate immature female rabbits. They were divided into three groups, receiving 800, 1600, and 2400 R total focal dose to the abdomen, fractionated for all three groups in daily doses of 200 R. In the 800-R group a nonuniform reduction of the ovaries to half the normal size was observed. Mature follicles were absent, and the residue of the follicles was seen in an early developmental stage distributed in a multilayer mass with severe cell structural alterations and regressive alterations of the theca interna. Some undeveloped follicles were observed lacking the oocyte, while a large number appeared to be undamaged. The same ovary changes as in the previous group were observed in the 1600-R group. The 2400-R group showed ovarian atrophy to ⅓ the normal size. The mature follicles appeared to be completely destroyed, as well as the follicles in the earlier evolutional stages. All maturing follicles in the ovaries were damaged but to a different degree. The follicles in the later evolutional stage showed nearly complete degeneration. The primary follicles showed varied lesions: in the 800-R group a large number were undamaged, a lesser number in the 1600-R group, and some follicles escaped destruction even in the 2400-R group. On the assumption that the regeneration is dependent on the undeveloped residual follicles which after a period can mature, a focal dose between 800 to 1600 R, administered in fractionated doses over five to ten days, is sufficient to guarantee a complete and permanent destruction of ovary function. (TCO)

15123 ON THE CONTROL OF UV-SENSITIVITY OF PHAGE T_4 BY THE GENE x. Walter Harm (Universitat, Cologne and School of Hygiene and Public Health, Baltimore). Mutation Res., 1: 344-54(Dec. 15, 1964).

DNA of uv-irradiated phages T_4 v^+x^+, T_4 v_1x^+, T_4 v^+x, and T_4 v_1x was used for competitive inhibition of photoenzymatic repair (photoreactivation) in vitro of uv-irradiated transforming DNA of Haemophilus influenzae. At a given uv-dose and at a given DNA concentration, the competitive power of all four DNA species was identical, indicating the presence of equal numbers of photorepairable uv-lesions in all cases. It is concluded that the quality and quantity of the primary uv-effects are identical for these four phage types, although they exhibit considerable differences in uv-sensitivity and in the extent of photoreactivation. Hence, not only the v gene, but also the x gene, controls the uv-sensitivity of phage by intracellular alteration of the uv-irradiated DNA. This conclusion is consistent with the results of rII^+ marker rescue experiments, showing that the extent of rescue is always lower if the unirradiated parental phages carry the x rather than the x^+ allele. A plausible explanation for these results is the control by the x gene of the frequency of genetic recombination, which is shown independently in crosses between unirradiated rII phages. To explain the increased uv-sensitivity of single-infecting T_4 x phage, it is tentatively assumed that the x allele, in contrast to the x^+ allele, does not permit a repair process which has some mechanism in common with genetic recombination. An alternative explanation would be that the x mutation concerns more than one gene. Additional experiments were carried out to study the superposition of the x gene effect with v gene repair in marker rescue. (auth)

15124 THE INDUCTION OF HOST-MUTATIONS IN EXTRACELLULAR PHAGES WITHOUT PRELIMINARY REPLICATION IN SENSITIVE CELLS. S. I. Alikhanyan and N. M. Mkrtumyan (Kurchatov Inst. of Atomic Energy, Moscow). Mutation Res., 1: 355-61(Dec. 15, 1964).

Host-range mutations of actinophages were produced by treatment of the free extracellular particles with ultraviolet light, nitrous acid, sarcolysin, or chlorambucil. In order to distinguish between mutations that do or do not require replication of DNA for their occurrence, the treated particles were tested either on a pure lawn of resistant cells or on a mixed lawn of resistant and sensitive cells, which allowed intermediate growth in the sensitive component. Nitrous acid-induced mutations appeared only on the mixed lawn; therefore it was concluded from this that they affect only the daughter chromosome of the originally treated one. The two alkylating agents sarcolysin and chlorambucil produced as many mutations by either method of plating; this suggests that these agents affect the whole treated chromosome by some mechanism other than changes in the nucleotide sequence. Ultraviolet light produced more mutations in phages plated on a mixed lawn, but was also somewhat effective when plating was done on the resistant strain only; this suggests that it can produce mutations by two different mechanisms. (auth)

15125 TEMPERATURE, TIME AND X-RAY MUTAGENESIS IN ESCHERICHIA COLI. Bryn A. Bridges and R. J. Munson (Medical Research Council, Harwell, Berks, Eng.). Mutation Res., 1: 362-72(Dec. 15, 1964).

Two effects of temperature in the range 16 to 37° on the induction by x radiation of reversions to prototrophy in tryptophan-requiring Escherichia coli WP_2 are described. The average number of mutable units which segregate from a nucleus at 16° (2.23) is greater than that at 37° (1.28). For this effect the temperature before irradiation is important and the most reasonable explanation postulates the existence at 16° of an appreciable G_2 period in the cell cycle during which DNA synthesis does not occur, so that in most nuclei two unseparated replicas of the genome are present. At 37° where it is known that any non-synthesizing period is very short, all nuclei presumably divide as soon as the chromosome has completed its replication. The segregation pattern at 37° is independent of whether

irradiation is carried out anoxically or aerobically and implies that most if not all mutations are carried on both strands of the segregating DNA. At 16° fewer mutations are scored per unit dose than at 37°. This low temperature mutation loss is mainly dependent on the post-irradiation temperature. Unlike some other supposed restoration systems it is magnified rather than prevented by acriflavine. It has the characteristics of a metabolic process, but there is no evidence to show whether this process leads to death or to return to normality of the premutational lesion. (auth)

15126 THE NATURE OF BACTERIAL REVERTANTS PRODUCED BY THE DECAY OF INCORPORATED TRITIUM COMPOUNDS IN ESCHERICHIA COLI. R. C. Bockrath, Jr., and Stanley Person (Pennsylvania State Univ., University Park). Mutation Res., 1: 373-80(Dec. 15, 1964).

The existence of two subclasses of revertants has been demonstrated among the revertant populations produced by [^{3}H]thymidine, [^{3}H]uracil, and [^{3}H]histidine decays in Escherichia coli. The majority of the total revertant population is composed of dependent revertants which give rise to revertant colonies in the presence of nutrient fortification. In addition, there are some independent revertants that form colonies in the absence of nutrient fortification. The relative mutagenic efficiencies for production of independent revertants are in the order: [^{3}H]thymidine, [^{3}H]uracil, and [^{3}H]histidine (in relative magnitudes 3.0, 1.4, 1.0, respectively). The disproportionately low yield of revertants in the independent subclass produced by one of the ^{3}H compounds ([^{3}H]uracil) infers that there are at least two molecular alterations that can mediate the reversion of a bacterial mutant by ^{3}H decay, and that the specificity of the ^{3}H compounds used is sufficient to affect differentially the proportions of these two alterations. (auth)

15127 REVERSION BEHAVIOR OF ISOLEUCINE-VALINE MUTANTS OF YEAST. S. N. Kakar, F. Zimmermann, and R. P. Wagner (All India Inst. of Medical Sciences, New Delhi; Universitat, Freiburg i.B.; and Univ. of Texas, Austin). Mutation Res., 1: 381-6(Dec. 15, 1964).

The various isoleucine–valine mutants obtained through ultraviolet irradiation were tested for reversion induction by nitrous acid and by ultraviolet light irradiation. The mutants can be classified into three categories: those which can be induced to revert by both nitrous acid and ultraviolet light; those which can be induced to revert by ultraviolet and not by nitrous acid; and those mutants which cannot be induced to revert either by nitrous acid or by ultraviolet light. Three of the isoleucine–valine requiring mutants produce half revertants in addition to full revertants. Depending upon the strain, the half revertants require one of the two amino acids for growth. From a particular strain only one kind of half revertants are obtained; they require either isoleucine (as in the case of half revertants from M-14 and Nr-211-1aM) or valine (as in the case of half revertants from M-12) for growth. Another mutant (M-11) produces revertants which are sensitive to valine, the valine inhibition being overcome by isoleucine. (auth)

15128 KINETICS OF X-RAY-INDUCED CHROMATID ABERRATIONS IN VICIA FABA AND STUDIES RELATING ABERRATION FREQUENCIES TO THE CELL CYCLE. J. Grant Brewen (Oak Ridge National Lab., Tenn.). Mutation Res., 1: 400-8(Dec. 15, 1964). (ORNL-P-53)

Lateral root tips of the broadbean, Vicia faba, were irradiated with 37.5, 75, or 150 R of x rays, after which continuous 2 hr colchicine collections of metaphase cells were made for a 20 hr period. The metaphase figures obtained at each 2 hr interval were scored for chromatid-type aberrations and the frequencies of the aberrations plotted against time after irradiation for each dose employed. The total number of chromatid-type aberrations induced by each dose, for the period of time studied, was calculated and a dose curve calculated for isochromatid deletions and chromatid exchanges. It was found that isochromatid deletions have primarily one-hit kinetics and chromatid exchanges have two-hit kinetics, as expected according to the classical theory of aberration production. Furthermore, the same results were obtained when a mitotically synchronous population of cells was irradiated. In addition, it was found that the frequency of isochromatid deletions induced by a given dose of x rays remains constant with time after irradiation, indicating an uniformity of stage sensitivity, whereas the frequency of chromatid exchanges is highest in those cells which were presumably in G_2 at the time of irradiation. This apparent increased G_2 sensitivity is interpreted as an increase in the number of sites within which an exchange can occur. (auth)

15129 THE EFFECT OF HYDROXYLAMINE ON THE REJOINING OF X-RAY-INDUCED CHROMATID BREAKS IN VICIA FABA. Norman S. Cohn (Ohio Univ., Athens). Mutation Res., 1: 409-13(Dec. 15, 1964).

Hydroxylamine produces significant levels of chromosomal breakage in plant and animal cells. Pursuant to treatment of plant root cells with this agent is the observation of little or no reunion of broken chromosome ends. The nature of the cytological effects of hydroxylamine has made it possible to study its influence on the production and rejoining of x-ray-induced chromosomal breaks. Lateral roots of Vicia faba were treated with 10^{-3}M hydroxylamine alone and in combination with x rays, including fractionated dose exposures. Hydroxylamine was employed in a phosphate buffer at pH 6.75, and administered to the roots for one hour. Analyses of chromatid breaks and aberrations at metaphase of mitosis were made with respect to their frequencies and to the patterns of reunion of the broken ends. A few chromosome-type aberrations were observed. An apparently synergistic effect is produced by combined treatment, and, of greater significance, the reunion of broken ends of chromosomes is reduced considerably below that found with x ray treatment alone. Reunion of isochromatid deletions was confined to either the distal (SUd) or proximal (SUp) ends, with many showing no reunion (NUpd). Of particular interest was the absence of complete reunion in a number of exchange aberrations. When a dose of 200 R was divided into two equal fractions of 100 R each and separated by an interval of one hour, differences in aberration frequencies were observed according to the conditions imposed during the interval. The presence of hydroxylamine between the two doses gave rise to an aberration frequency considerably higher than that found when the roots were held in water between x ray exposures. This result provides strong support for the conclusion that hydroxylamine inhibits the rejoining events. Hydroxylamine, therefore, not only causes chromosomal breaks, but also inhibits their rejoining. The mechanism of rejoining inhibition may involve some alteration of enzyme activity necessary for restitution and reunion and/or an impairment of DNA synthesis but no direct information is yet available to support these possibilities. (H.M.G.)

15130 THE BROOD-PATTERN OF X-RAY-INDUCED MUTATIONAL DAMAGE IN THE GERM CELLS OF DROSOPHILA MELANOGASTER MALES. Aloha Hannah-Alava (Univ. of Turku, Finland). Mutation Res., 1: 414-36 (Dec. 15, 1964).

From the results of two experiments, comparisons were made of the frequencies of induced crossovers in the third chromosome and three types of mutations (visibles at nine specific third-chromosome loci, dominants and Minutes in all chromosomes) in successive broods of offspring from Drosophila melanogaster males mated singly and sequentially up to 24 days following treatment with 3000-R x rays. The highest frequency of crossovers was in the 10 to 11-day broods, but large and continuing clusters were first found in the 12 to 13-day broods. Each mutational type, with the probable exception of the dominants, had a characteristic brood curve of mutation frequencies, but all were similar in that the rates were higher for spermatids (4 to 6 days) than for mature sperm (1 to 3 days). With one exception, the highest rates were in the 6 to 8-day broods, but as this was the period of excessive sterility the differences may not be significant. The rates in the post-sterile broods were substantially lower than the rates in the presterile broods. The evidence supports the concepts of a stem-cell mechanism for maintenance of the germ line in D. melanogaster males, and points to the probability that

the size and distribution of crossover clusters is a reliable criterion for relating the temporal and spatial pattern of the spermatogonial stages. On the basis of this criterion, the 9 to 11-day broods, in all probability, were derived primarily from definitive, the 12th-day brood from both definitive and predefinitive, and the later broods from predefinitive spermatogonia. Since the clusters of mutations were smaller than the crossover clusters and seldom continued for more than two broods, it may be that radiogenetic damage to a predefinitive spermatogonium is accompanied by damage that leads to lethal loss of the cell after one or two predefinitive divisions. The progressive decrease in frequency of crossovers and mutations in successively later post-sterile broods has been interpreted as the consequence of both random and lethal loss of the mutated predefinitive spermatogonia, but progressive repopulation of the testes by nonmutated cells could not be ruled out as a contributing factor. (auth)

15131 A COMPARISON OF GENETIC CHANGES INDUCED BY A MONOFUNCTIONAL AND A POLYFUNCTIONAL ALKYLATING AGENT IN DROSOPHILA MELANOGASTER. L. A. Snyder and I. I. Oster (Univ. of Minnesota, St. Paul and Inst. for Cancer Research, Philadelphia). Mutation Res., 1: 437-45(Dec. 15, 1964).

A comparison of the spectra of genetical changes induced in mature spermatozoa by a mono- and a polyfunctional alkylating agent and by γ-rays was made using multipurpose stocks having an Y-chromosome genetically marked at both ends. Gamma rays, typical of ionizing radiations, cause higher frequencies of entire Y- (or X-) chromosome losses than of partial losses of the Y-chromosome. Polyfunctional triethylene melamine, in contrast, was found to induce substantially fewer entire chromosome losses than the sum of losses involving the marker loci on either arm of the Y. Based on a limited sample of partial losses, the relative incidence of sterility among males having lost one or the other of the marker loci after treatment with the polyfunctional chemical was almost twice that found in comparable groups of males following irradiation. Similar data obtained after treatment with monofunctional quinacrine mustard appear to agree with those obtained using the polyfunctional compound, but are too limited to be conclusive. Both the monofunctional and polyfunctional chemicals were found to induce high frequencies of mutations at the dumpy locus, and in both cases very high proportions of these changes were mosaically expressed. On the basis of these results it appears unlikely that the number of reactive groups present in an alkylating compound influences the relative frequency of mosaic changes produced. (auth)

15132 THE FREQUENCY OF INDUCED TRANSLOCATIONS IN SPERMATOGONIA. C. Auerbach and H. Slizynska (Inst. of Animal Genetics, Edinburgh). Mutation Res., 1: 468(Dec. 15, 1964).

The frequencies of translocations in spermatozoa and spermatogonia of x-rayed mice are compared. A rough estimate of 6:1 is derived for the frequencies of translocations per genome per R in these two types of cells. It is pointed out that this is an overestimate of the ability of spermatogonia to form translocations. Account has to be taken of the fact that a given number of breaks per genome has a higher chance of yielding a translocation when the breaks occur in the two genomes of a diploid spermatogonium than when they are distributed over two genomes in separate spermatozoa. If a given dose of x rays produces a frequency of 0.1 breaks per genome, then the highest possible number of translocations formed in two genomes of spermatozoa is $(0.1^2 + 0.1^2) = 2\%$, while the highest number of translocations formed in a diploid spermatogonium is $(0.2)^2 = 4\%$. This calculation neglects the correction for undetected translocations between homologous chromosomes in spermatogonia; but for a cell with many chromosome pairs this correction is small. Thus, if every break took part in a translocation, a given frequency of breaks per genome would produce roughly twice as many translocations in spermatogonia as in spermatozoa. If radiation response in the two types of cells is measured on the basis of this expectation, then a ratio of 6:1 for observed translocations in spermatozoa and spermatogonia means that the response of spermatozoa is 12 times that of spermatogonia. No similar considerations apply to mutations at specific loci which, after a given dose of x rays, are about twice as frequent per genome in spermatozoa as in spermatogonia. If sensitivity to chromosome breakage, too, were twice as high in spermatozoa as in spermatogonia, this could at best explain a 4-fold frequency of translocations in spermatozoa (2-fold according to the above considerations, but half of the symmetrical translocations in spermatogonia will be lost at meiosis). Thus in order to explain the 12:1 ratio for translocations, one has to assume either that spermatogonia and spermatozoa differ from each other more in sensitivity to chromosome breakage than in sensitivity to mutation or that conditions in spermatogonia inhibit the formation of translocations. (auth)

15133 STUDIES OF CELL PROLIFERATION UNDER CONTINUOUS IRRADIATION. L. F. Lamerton and B. I. Lord (Royal Cancer Hospital, Surrey, Eng.). Natl. Cancer Inst. Monograph, 14: 185-98(May 1964).

Radiosensitivity of dividing cells was studied in various tissues of young rats exposed continuously to ^{137}Cs γ radiation at dose rates of 4 to 400 rad/day. The renewal tissues differed greatly in the dose rate they tolerated. Thus, the epithelium of small intestine maintained function and a steady cell population (somewhat smaller than normal) at a dose rate as high as 400 rad/day. Bone marrow maintained a steady state of cell population only at dose rates of 50 rad/day and below, and the testis was far more sensitive to continuous irradiation than bone marrow. The various tissues also differed in the way in which the normal pattern of cell proliferation changed under continuous irradiation. Studies are also reported on the response of continuously irradiated tissues to stress requiring increased proliferation. It is concluded that continuous exposure does not necessarily lead to an accumulation of damage affecting the regenerative capacity of renewal tissues, even at quite high dose rates. Possible reasons for the much greater tolerance of the gut to continuous irradiation, compared with the bone marrow are discussed. (TCO)

15134 AN IMMEDIATE EFFECT OF X-RADIATION ON THYMUS CELLS. D. K. Myers (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nature, 205: 365-7 (Jan. 23, 1965).

An investigation is described in which an immediate effect of x irradiation on one constituent of the cell nucleus was demonstrated without any of the manipulations involved in isolation of the nuclei from irradiated cells. Rat thymocyte cell suspensions and alkaline NaCl solution were mixed within 0.5 min after completion of a 1 kRad x radiation exposure. An appreciable alteration in viscosity due to irradiation of the intact cells was measured 0.5 min after mixing with alkaline NaCl, that is, within 1 min after irradiation. Since the results were essentially similar whether the cell suspensions were held at 0°C either for 0.5 min or for more extended periods of up to 2 hr after irradiation before mixing with alkaline NaCl, it was concluded that the viscosity increase represents an immediate effect of x irradiation. The rate of gel formation was appreciably affected by doses down to 35 Rads of x irradiation. The same effect of x irradiation was also demonstrated with cell suspensions prepared from the thymus gland of irradiated rats. Cell suspensions prepared within 3 min after exposure of the whole animal to 1 kRad x irradiation exhibited the same increase in speed of gel formation as was observed after x irradiation in vitro, again with little effect on the maximum viscosity of the gel after standing for longer periods in alkaline NaCl solution. (P.C.H.)

15135 A MODEL OF TUMOUR GROWTH IN IRRADIATED HOSTS. William C. Summers (Univ. of Wisconsin, Madison). Nature, 205: 414(Jan. 23, 1965).

A model is described that gives a precise interpretation of tumor growth in irradiated hosts. It is assumed that a tumor consisting of n cells will double as soon as it

has been exposed to a given quantity per cell of some limiting metabolite. The resulting equation predicts the expected relation between the growth rate of the control tumor and the growth rate depression induced by prior irradiation of the host. The magnitude of the effect of pre-transplantation irradiation of the tumor bed appears to be related to the normal growth rate of the tumor. The relation that exists can be predicted by assuming quantitative alterations in the effective capillary bed and in the transcapillary flux. (P.C.H.)

15136 FACTORS INFLUENCING BIOMAGNETIC ENVIRONMENTS DURING THE SOLAR CYCLE. W. C. Levengood (Univ. of Michigan, Ann Arbor). Nature, 205: 465-70 (Jan. 30, 1965).

The results are presented of a study of the variation of the reproductive response of Drosophila melanogaster, when grown in magnetic fields, with solar activity. The flies were grown in culture bottles placed on the opposite poles of permanent magnets. The effects of cosmic radiation, solar flare activity, barometric pressure, and the outer Van Allen Radiation Belt on progeny yields were studied. Possible mechanisms for the observed trends are considered. (D.C.W.)

15137 EFFECT OF X-RAY DOSE ON THE GROWTH RATE AND DELAY OF THE FIRST POST-IRRADIATION DIVISION IN A STRAIN OF PARAMECIUM AURELIA. John Calkins (Univ. of Kentucky, Lexington). Nature, 205: 511-13(Jan. 30, 1965).

Log phase Paramecium aurelia were x irradiated at 43 kRads/min. Isolated animals were counted at intervals suitable for the determination of growth rate. It was found that the x rays produced a progressive delay of the first division following the exposure. When growth did resume, and for the first four divisions after the resumption, the rate of growth of the population was constant within the resolution of the method of growth rate measurement used. The growth rate was progressively reduced with increasing x-ray dose. Plots of growth rate curves are illustrated and discussed. (P.C.H.)

15138 EFFECT OF WHOLE-BODY X-IRRADIATION ON ^{14}C-LEUCINE INCORPORATION INTO PROTEINS OF CELL NUCLEI OF REGENERATING RAT LIVER. Neda Sestan (Institute "Rudjer Boskovic," Zagreb). Nature, 205: 615(Feb. 6, 1965).

An investigation was made on the effects of whole-body x irradiation, at different time intervals within 24 hr after partial hepatectomy, on amino acid incorporation into proteins of cell nuclei isolated from 24 hr regenerating rat liver. Irradiated rats received 900 R of x rays at 2, 6, and 16 hr after partial hepatectomy. The results showed that ^{14}C-leucine incorporation into proteins of regenerating liver nuclei was inhibited by 20 to 25% when irradiation was given 2 or 6 hr after partial hepatectomy. No inhibition was observed when rats were irradiated 16 hr after operation. The results indicate that the mechanisms of nuclear and cytoplasmic protein synthesis are closely interdependent in growing liver cells. (P.C.H.)

15139 HEREDITARY CATARACT INDUCED BY X-IRRADIATION OF YOUNG RATS. A. Leonard and J. R. Maisin (Centro d'Etude de l'Energie Nucleaire, Mol, Belg.). Nature, 205: 615-16(Feb. 16, 1965).

Cataracts were observed in the F_3 generation of a 17-day-old female irradiated with 150 R of whole-body x irradiation. At the age of 70 days, the female was mated with a control male and produced F_1 and F_2 progeny with normal eyes. In the F_3 generation about 25% had cataracts although all animals were not affected at the same time: at weaning about 75% of the mutant offsprings showed bilateral cataracts while one or both lenses of 25% appeared to be normal. At 70 days of age, bilateral cataracts were present in all mutants. The breeding tests established that this mutation is inherited as a simple recessive factor: the mating between cataractous male and female gave 100% of cataractous offspring while the mating between an animal with cataract and a normal one resulted in a normal progeny the offsprings of which showed an incidence of cataracts in a ratio of 1/1. (P.C.H.)

15140 ROLE OF THE OLFACTORY SYSTEM IN AROUSAL TO X-RAY. C. D. Hull, J. Garcia, N. A. Buchwald, B. Dubrowsky, and B. H. Feder (Veterans Administration Hospital, Long Beach, Calif. and Univ. of California, Los Angeles). Nature, 205: 627-8(Feb. 6, 1965).

A study was made on the effectiveness of x ray as an arousing stimulus in rats in which the olfactory bulbs had been removed. De-synchronization of a previously synchronized electroencephalogram (EEG) within 2 sec following the onset of the x ray was the criterion of effective arousal. The results showed that x ray exposure that produced a prompt arousal in control animals had little effect on the animals without olfactory bulbs. The frequency of the animals exhibiting one or more arousals was statistically greater ($P < 0.01$) for control groups than for the comparable experimental groups at the 0.5 and 1.0 R/sec dose rates. The results indicated a distinct loss of sensitivity when the olfactory bulbs were removed. This agrees with previous work in which a collimated x-ray beam was used as a conditioned stimulus to demonstrate a maximum sensitivity in the region of the olfactory bulbs. (P.C.H.)

15141 A RADIATION-INDUCED CHIMERA IN ANNUAL CHRYSANTHEMUM. R. S. Rana (Indian Agricultural Research Inst., New Delhi). Naturwissenschaften, 51: 642-3 (1964).

A chlorophyll chimera observed in X_1 population of Chrysanthemum cyrinatum grown from seeds subjected to an acute x-ray dose of 15 kr is reported. A sectorial albino branch showing lack of chlorophyll with the other side developing normally bore flowers on both sections, permitting cytological studies of microsporogenesis. The chromosome number of the albino sector was 16 instead of the normal 18, and multiple chromosome association was absent. This indicates a possible cause-and-effect relation between chromosome deficiency and lack of chlorophyll and shows that normal chlorophyll development in annual chrysanthemum is under chromosomal control. (J.S.R.)

15142 EXPERIMENTAL STUDY ON NEUTRON-INDUCED CATARACTS. II. CATARACTOGENIC DOSE OF FAST NEUTRONS IN RABBITS. Kanji Choshi (Hiroshima Univ.). Nippon Ganka Gakkai Zasshi, 67: 1896-1901 (Oct. 1963). (In Japanese)

Attempts were made to determine the threshold dose of fast neutrons that will cause permanent damage to the crystalline lens of adult albino rabbits. Fast neutrons (14.1 Mev) were from a T-D reaction neutron generator. The course of the clinically observed opacities of the lens in groups of adult rabbits were followed for more than 47 weeks (the longest time was 91 weeks) after irradiation. In the low-dose exposed groups (2.5×10^8 to 2.0×10^9 n/cm^2), the change in the lens was very slight. The opacities increased slightly following their development, then either remained unchanged or even decreased in some cases during the period of observation. In the medium-dose exposed groups (4.0×10^9 to 1.6×10^{10} n/cm^2), slight evidence of increase in opacity was noted, but after reaching a certain degree, the opacity became stationary. Presumably, permanent damage will result from such doses. In the high-dose exposed groups (3.2×10^{10} to 9.6×10^{10} n/cm^2) the degree of opacity was greater than in the medium-dose group, and the change was such that impairment of vision could be expected. Opacity showed a trend toward gradual increase through the period of observation. However, in no case did total opacity develop. The threshold dose of fast neutrons that would produce permanent damage and where diminishing vision could be expected was found to be 3.2×10^{10} n/cm^2 or less. This is higher than that required for 10-week-old rabbits as reported previously (8.4×10^9 n/cm^2). (BBB)

15143 STUDY OF THE PROBLEMS IN THE MEASUREMENT OF DOSE. Ikuo Kimura (Roentgen Technical School, Japan). Nippon Hoshasen Gijutsu Gakkai Zasshi, 19: No. 1, 1-38(July 1963). (In Japanese)

Problems associated with the measurement of exposure dose are discussed. A description is given of the accuracy in measuring exposure dose upon irradiation with medium energy (5–500 kv) and high energy (500 kv–3 Mev) x rays. Operating characteristics of some commercially available

dosimeters are compared. Problems associated with medical applications of x rays are also considered. Properties of x rays are discussed primarily with regard to half-thickness of absorbers and absorption curves. Measurement of high energy x rays and gamma radiations followed by high energy beta ray measurements are reported. A discussion of the cavity theory follows in which the Bragg-Gray, Spencer-Attix, and Burch approaches are described and compared. Distinction is made between the concepts of dosimetry and radiometry. (TTT)

15144 THE MECHANISM OF THE CHANGES IN ELECTROKINETIC POTENTIAL OF SARCOMA CELLS FOLLOWING X IRRADIATION. Shigeru Shibata (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 1315-26(Mar. 25, 1963). (In Japanese)

In a study of the changes in electrokinetic potential of sarcoma cells following x irradiation, it was found that when radiation and agents such as Nitromin, hydrogen peroxide, and succinic acid caused maximum changes followed by the recovery of electrokinetic potential in sarcoma cells, changes were observed in electrolyte composition in ascites fluid as shown by measurements or inorganic electrolyte, paper chromatography, and infrared spectrum. No change in Na, K, and Cl of ascitic fluid was found due to irradiation. Several free amino acids were detected in sarcoma cells. Irradiation, Nitromin, and hydrogen peroxide caused increases of glycine, glutamic acid and threonine, but a decrease of glutamic acid and threonine was caused by succinic acid. The changes in free amino acid of sarcoma cells caused by x irradiation and the other agents were also restored to normal when the electrokinetic potential of sarcoma cells recovered its normal level. The infrared absorption spectra of sarcoma cells showed bands chiefly at 3300 to 2800 and 1700 to 750 cm^{-1}. The relative absorbancy indexes in the 3300 and 1650 cm^{-1} regions were decreased by irradiation, Nitromin, and succinic acid. The relative absorbancy indexes in the 1550 and 1530 cm^{-1} regions were increased by irradiation and Nitromin but decreased by succinic acid. The changes in the electrokinetic potential of sarcoma cells caused by irradiation and the agents corresponded with the changes of free amino acid and infrared spectra of sarcoma cells in the 3300, 1650, 1550, and 1530 cm^{-1} regions. It is suggested that the changes in the electrokinetic potential of sarcoma cells are based on alterations of intracellular metabolism. The changes in free amino acids of sarcoma cells are explained by feedback inhibition and repression of amino acid metabolism. (BBB)

15145 RESTITUTION PHENOMENA IN PLANT MERISTEMS AFTER X IRRADIATION. II. ADVENTIVE EMBRYONY AFTER SEED IRRADIATION OF ERANTHIS HIEMALIS. Barbara Haccius and Hans Reichert (Universitat, Mainz). Planta, 62: 355-72(1964). (In German)

Histologic studies were conducted on young undifferentiated embryos of E. hiemalis exposed to x rays at doses of 1000 to 4000 R to observe their further development. After the 4000-R dose, mitotic activity is completely and irreversibly arrested, but the cell outline remains unchanged. The embryos treated with doses between 1000 and 2000 R are also severely damaged, showing radical disorganization of the tissue due to degeneration and necrosis. In these embryos small cell groups or even single cells are able to regain their mitotic potency. Meristematic centers (embryoids) arise and develop into normal or sometimes misformed viable adventive embryos. This restitution takes place only in x-ray-treated embryos whose cell coherence is severely disturbed, a condition which is absent not only after exposure to low (<1000 R) but also to high (4000-R) x-ray doses. It is concluded that the somatic cells of young embryos are totipotent when released from the influence of their environment. Since the adventive embryos are more exposed to developmental disturbances than the zygotic ones, they show a higher percentage of morphologic anomalies. Therefore, it is necessary, when dealing with the so-called x-ray induced cotyledonary anomalies, to distinguish between true x-ray damage of the original embryo and indirect teratogenic effects in the case of adventive embryony. These results are discussed and correlated with findings in other plant species. (BBB)

15146 POSSIBLE ETIOLOGICAL SIGNIFICANCE OF THE AGE-PATTERN OF CERTAIN DISEASES. P. R. J. Burch. Postgrad. Med. J., 40: 151-3(Mar. 1964).

The possible role of ionizing radiation in the causation of malignant diseases is considered. At Hiroshima the clinical onset of leukemia in survivors was delayed and did not reach its max rate until six to seven years after the nuclear explosion. Reasons are advanced for supposing that in many cases irradiation completed the initiation phase of leukemogenesis but that promotion or development required typically a latent period of six to seven years. The distribution of the latent period followed a bell-shaped or Gaussian-type curve, and was not noticeably age-dependent. The latent period distribution was very similar for both chronic and acute leukemias, suggesting that the time of growth from one or a few cells to clinical leukemia did not constitute a major part of this time lag. It is concluded that the first mutational stage is often already present in the zygote (deriving from one of the germ cells) and that three somatic mutations (genic or chromosomal) together with a stage of hyperplasia, are needed to complete the initiation phase. (TCO)

15147 A NEW ATTEMPT AT RENAL TRANSPLANTATION BETWEEN UNRELATED PERSONS—FAVORABLE DEVELOPMENT BEYOND A YEAR. R. Kuess, M. LeGrain, G. Mathe, R. Nedley, and M. Camay (Centre Medico-Chirurgical Foch and Institut National d'Hygiene, Paris). Presse Med., 71: 445-8(Feb. 1963). (In French)

A female patient who underwent a left nephrectomy for tuberculosis developed nephropathy in the remaining kidney a year later. No tuberculosis was present, so it was decided to replace the kidney with a transplanted one from a 44-year old male patient. The donor kidney was healthy but had to be removed because of another operation. The erythrocyte blood groups of the donor and receiver were identical for the majority of antigens. There were some differences in the leukocyte antigens but these did not constitute an obstacle to the transplantation. The recipient was whole-body irradiated with a 250-Rad dose the day before transplantation. After the operation 100 mg of cortisone was administered to her for two days, then 50 mg of Δ^1-cortisone for a week. One g of streptomycin and 300 mg isoniazid were administered as a precautionary measure because of the previous tuberculosis. The 2nd, 3rd, and 8th postoperative days the graft was irradiated with 100-R doses. A 10% mannitol solution was perfused by way of the renal veins the 4th, 5th, 8th, and 9th days. Staphylococcal septicemia appeared the 23rd day and was treated, first with penicillin-cathomycin, then with 8 g of flabellin per day from the 22nd to the 40th day after the initial irradiation. With the septicemia cured, the patient was given 100 to 150 g of 6-mercaptopurine per day from the 2nd to the 7th month. Urography in the 2nd month showed excellent renal function and a normal excretory duct. Δ^1-cortisone was given again from the 3rd to the 7th month in doses of 15 to 20 mg per day. The white blood cell count remained around 3000 per mm^3 most of the time, while the number of platelets varied between 70,000 and 100,000. The red blood cell count was maintained above three million by transfusing six liters of blood over a period of five months. From the 7th to the 12th month 6-mercaptopurine was administered in doses of 25 to 50 mg per day. The blood count remained normal without transfusions. A year after the transplantation the patient was completely normal and the renal function was like that of a healthy kidney. The technique of whole-body irradiation with a sublethal dose before transplantation and doses of 6-mercaptopurine after appears to be a valid way of insuring viable transplants between unrelated persons. (BBB)

15148 BONE DAMAGE IN DOGS FROM RADIOSTRONTIUM. Birute O. Biskis and Miriam P. Finkel (Argonne National Lab., Ill.). Proc. Inst. Med. Chicago, 25: 23-4 (Mar. 1964).

Dogs were exposed to ^{90}Sr-^{90}Y, which localizes in and irradiates bone, to provide data on animals between mice

and men in body size and life span. Such data are necessary for making the appropriate corrections in extending mouse data to estimate the potential danger of ^{90}Sr to man. Bone pathology resulting from a single intravenous isotope injection was studied in beagles, comparing the effects of age and uniformity of deposition with others that received ^{90}Sr in the same total amount but as subcutaneous injections given five times a week for one yr. Newborn, juvenile, or adult dogs were used. Pathologic changes were seen after a single injection throughout the cortical and trabecular bone, including death of osteocytes, bone resorption, endosteal fibrosis, periosteal bone growth, and neoplasia. The same amount of radionuclide given in 278 fractions during the first yr of life produced major damage in the cortex only. Four to six months after the injections were started, focal damage of the epiphyseal cartilage appeared and atypical fibrous bone was formed. During the next year there was intensive resorption of the damaged bone, which was replaced with fibrous tissue. Adjacent to the remaining old damaged bone, shell-like layers of imperfect membranous bone were formed. Occasionally small foci of new bone formation appeared within the fibrous tissue, and occasionally developed into osteogenic sarcomas. Another repair process, periosteal proliferation, was abundant during this period, and also frequently led to tumor formation. (BBB)

15149 TISSUE CHANGES INDUCED BY CERIUM-144 AND CESIUM-137. Louise S. Lombard (Argonne National Lab., Ill.). Proc. Inst. Med. Chicago, 25: 24-5(Mar. 1964).

Lesions in beagles dying subsequent to intravenous injection of ^{144}Ce and ^{137}Cs in toxic doses ($LD_{50/30}$) were grossly similar but microscopically dissimilar. The gross lesions in both included hemorrhages within all major organs and tissues, bone marrow aplasia and lymphoid hypoplasia. Cerium-144, an energetic β emitter, localized in the reticuloendothelial cells and in bone. Cesium-137, also a β emitter, was widely distributed within the body, and delivers a uniform radiation dose. Distribution of the two radionuclides resulted in major differences in doses of radiation delivered to specific volumes of tissues; thus a total dose of ^{137}Cs 35 times greater than that of ^{144}Ce was necessary to attain the $LD_{50/30}$ level. Irradiation of bone marrow from ^{144}Ce deposited in the endosteum of bone caused aplasia at a dose of 100 μC/kg of body weight, whereas for the same effects with ^{137}Cs, 3500 μC/kg was necessary. Less than 5% of the ^{144}Ce was excreted in the feces and urine within 30 days, but more than half of the ^{137}Cs. Although renal damage resulted from injection of both radionuclides, the changes associated with ^{144}Ce were glomerular, while those with ^{137}Cs were primarily tubular. The glomerular tufts contained focal areas of acellularity, and tubular fatty changes involved the entire nephron, including the glomerular tuft. The convoluted tubules had areas of acellularity and pyknotic nuclei, and the lumen contained casts of sloughed epithelial cells and erythrocytes. Myopathy, vacular emboli, infarcts, and testicular atrophy were limited almost entirely to the ^{137}Cs-irradiated dogs. Myocardial and skeletal muscle of ^{137}Cs-treated dogs showed local regions of atrophy, degeneration, and necrosis. Altered glycogen metabolism was observed in the skeletal muscles and to a less extent in myocardial muscle. Abundant glycogen was present in the form of a cuff beneath the sarcolemma. Emboli appearing within the venules consisted of fibrin, granular and hyaline masses, and round to oval vacuolated bodies. All stained with the periodic acid-Schiff test and were not digested by diastase. Encapsulation of the round vacuolated bodies was considered to be a surface tension phenomenon due to the combination of lipid, protein, and mucopolysaccharide. Infarcts were found in the myocardium. Reticuloendothelial cells in the liver, spleen, lymph nodes, and lung contained phagocytized mucopolysaccharides and lipids. The only cells remaining within the seminiferous tubules of the testes were Sertoli cells and pathobiotic spermatogonia. (BBB)

15150 H^3 THYMIDINE UPTAKE BY A RING X-CHROMOSOME IN A HUMAN FEMALE. J. Rowley (Argonne Cancer Research Hospital, Chicago), S. Muldal, J. Lindsten, and C. W. Gilbert. Proc. Natl. Acad. Sci. U. S., 51: 779-? (1964). (ACRH-22(p.53-61))

The use of H^3 thymidine to label cultures of peripheral leukocytes revealed a marked asynchrony in the replication of one chromosome in the normal human female. The hypothesis that this chromosome, which labels late in the period of DNA synthesis, is one of the two X-chromosomes, is supported by the finding of three late labeling chromosomes in males with the karyotype XXXXY, four late labeling chromosomes in a female XXXXX, and one large late labeling chromosome in patients with gonadal dysgenesis and the karyotype XX_1, where the large X_1 chromosome is presumed to represent an isochromosome for the long arm of one X-chromosome. Results are reported from autoradiographic studies carried out on metaphases of leukocytes from peripheral blood obtained from a 22-year-old woman with gonadal dysgenesis whose cells contain 45, 46 and 47 chromosomes with a karyotype $XO/XX_R/XX_RX_R$ respectively (ring = X_R). The ring X-chromosome was present in 30 per cent of the metaphases cultured from peripheral blood. Cells from long term cultures of skin and ovary showed 45 chromosomes and were XO; in repeat short term cultures of skin and a lymph node, about 10 per cent of the cells contained 46 chromosomes and were XX_R. Some cells from these short term cultures were sex chromatin positive. Buccal mucosa smears showed no sex chromatin bodies. Normal appearing drumsticks were present in 9 of 500 neutrophil leukocytes. Results indicate that in metaphases containing morphologically abnormal X-chromosomes, only the abnormal X is late labeling. (C.H.)

15151 ACRIFLAVINE RESISTANCE: A BACTERIOPHAGE MUTATION AFFECTING THE UPTAKE OF DYE BY THE INFECTED BACTERIAL CELLS. Simon Silver (Medical Research Council, London). Proc. Natl. Acad. Sci. U. S., 53: 24-30(Jan. 1965).

Experiments on the uptake of acriflavine by uninfected E. coli cells and by cells infected with acridine-sensitive or -resistant bacteriophage show that: sensitivity to acriflavine is related to a greatly increased uptake of dye by infected cells; one of the two mutations to acridine resistance in bacteriophage T2 and T4 results in a reduced uptake of dye; and the process responsible for increased acriflavine uptake is dependent on phage-directed protein synthesis in the infected cells. (auth)

15152 ENHANCEMENT OF NATURAL HEMOLYSIN IN ADULT RABBITS AFTER RADIATION. William H. Taliaferro and Lucy Graves Taliaferro (Argonne National Lab., Ill.). Proc. Natl. Acad. Sci. U. S., 53: 139-46(Jan. 1965).

Unimmunized adult rabbits show a mean Forssman hemolysin titer of 1.48 ± 0.03 log units. Heavy total body irradiation (500 to 600 R) of such rabbits induced the following changes in this so-called natural Forssman hemolysin: a two-phase decline to a low titer (1.10 ± 0.06 log units) in about two weeks, recovery in about one week to the preirradiation titer, one or two subsequent transient periods of enhanced titer, and a return to normal values at 4 months. The radiation-induced enhanced peak titers (1.97 ± 0.05 log units) were significantly higher than the preirradiation titer. Radiation with 300 R produced similar but smaller changes. These results are compatible with the assumption that the so-called natural Forssman hemolysin of the rabbit is identical with the immune gamma-1 Forssman hemolysin and never reaches high titers or engenders anamnestic sensitivity because of insufficient antigenic stimulation. (auth)

15153 INDUCTION KINETICS AND GENETIC ANALYSIS OF X-RAY-INDUCED MUTATIONS IN THE AD-3 REGION OF NEUROSPORA CRASSA. B. B. Webber and F. J. de Serres (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 53: 430-7(Feb. 1965). (ORNL-P-611)

An analysis of the induction of ad-3^R and ad-3^{IR} mutations in a balanced dikaryon of Neurospora crassa with x irradiation showed that they have different induction kinetics. Ad-3^R mutants showed single-hit kinetics, while ad-3^{IR}

mutants showed two-hit kinetics. The spectrum of x-ray-induced forward mutation in the ad-3 region was dose-dependent; whereas at 1 kR, 97% of the mutants were ad-3^R (and affected only the ad-3A locus or ad-3B locus), at 40 kR, 56% were ad-3^{IR} and 26% inactivated both the ad-3A and ad-3B loci. Estimates of the forward-mutation rates for the two loci in the ad-3 region were 1.7×10^{-9} mutants · R^{-1} · $survivors^{-1}$ for ad-$3A^R$ mutants and 3.64×10^{-9} mutants · R^{-1} · $survivors^{-1}$ for ad-$3B^R$ mutants. A minimal estimate for the incidence of the hits that cooperate to give ad-3^{IR} mutants was 4.01×10^{-7} hits · R^{-1} · $survivors^{-1}$. The finding that the spectrum of x-ray-induced mutations in the ad-3 region includes both intragenic and extragenic alterations made it possible to reconcile the differences observed in previous analyses of x-ray-induced mutations in haploid and diploid organisms. (auth)

15154 THE SHORT-TERM EFFECTS OF ACUTE X-IRRADIATION ON OOGONIA AND OOCYTES. Heather M. Beaumont (Univ. of Birmingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 161: 550-70(Feb. 16, 1965).

Fetal rats were exposed to 100 R (acute x irradiation) at 15.5, 16.5, and 17.5 days of intrauterine life, and killed at daily intervals up to 20.5 days post coitum (p.c.). The populations of normal and degenerating germ cells in irradiated ovaries were estimated by a volumetric method. The chromosomal configurations of germ cells were examined in both histological and squash preparations. Irradiation appeared to disturb the close developmental synchronization of germ cells. Many irradiated cells also showed transient changes in chromosomal morphology, and an increase in cell and nuclear volumes. The treatment induced both immediate cell death (i.e. within 24 hr of exposure) and delayed cell death. The latter became manifest by an increase in the incidence of degenerating cells of the same type as arise spontaneously during normal development (atretic divisions; Z cells). The most severe depletion in the total population of germ cells occurred following exposure at 15.5 days, only some 13000 germ cells being present 24 hr later (cf. 37000 in coeval controls). Their number was further reduced to about 5000 at 20.5 days (cf. 56000 in controls). In contrast, the mean populations at 20.5 days following irradiation at 16.5 and 17.5 days were 16000 and 42500, respectively. Most degenerating germ cells were eliminated from the ovary by 20.5 days. The subsequent loss of oocytes with age (up to 25 and 100 days p.c.) occurred at a lower rate in irradiated than in normal animals. (auth)

15155 HADACIDIN POTENTIATION OF LETHAL ACTION OF IONIZING IRRADIATION. I. EFFECT OF MAMMALIAN TUMOR CELLS IN CULTURE. Glen J. Dixon, Margaret M. Blackwell, and Frank M. Schabel, Jr. (Southern Research Inst., Birmingham, Ala.). Proc. Soc. Exptl. Biol. Med., 118: 521-5(Feb. 1965).

The effects of hadacidin on radiation damage to mammalian cells was investigated. In evaluating the experimental data, the fraction of surviving cells treated with hadacidin alone was determined and the fraction of surviving cells treated with hadacidin plus radiation was corrected for hadacidin toxicity. The results showed that the lethal effects of x irradiation on Ca755, KB, and HeLa (S-3) cells were potentiated by hadacidin. Under similar conditions, no potentiation of the lethal effect was seen with Sa180 cells and the results with H.Ep-2 cells were inconsistent and equivocal. With Ca755, KB, and HeLa (S-3) cells, the degree of potentiation was related to the dose of both x ray and hadacidin. (P.C.H.)

15156 HADACIDIN POTENTIATION OF LETHAL ACTION OF IONIZING IRRADIATION. II. EFFECT ON PROLIFERATING GRAM-NEGATIVE BACTERIA. Robert F. Pittillo and F. Carolyn Moncrief (Southern Research Inst., Birmingham, Ala.). Proc. Soc. Exptl. Biol. Med., 118: 525-9(Feb. 1965).

The activity of hadacidin as a radiopotentiator in microbial systems was investigated. The effects of the amount of time growing cells are exposed to hadacidin has on the compound's irradiation-potentiating ability was investigated. Also, the sensitivity of cells from different points in the growth cycle to the hadacidin effect was determined. It was concluded that hadacidin is a potent potentiator of the lethal effects of irradiation on proliferating cells of a number of Gram-negative organisms. It appeared that for hadacidin potentiation of irradiation to be demonstrated, a damaging dose of irradiation must be used and that the compound must be present either prior to or during irradiation. The results also suggest that hadacidin potentiates irradiation damage regardless of the physiological age of the cells at the time of addition of hadacidin or the amount of time the cells are exposed to it during growth. (P.C.H.)

15157 SURVIVAL AND DARK GERMINATION OF X-IRRADIATED ARABIDOPSIS THALIANA, RACE ESTLAND. S. K. Devi, K. N. Prasad, and E. F. Riley (Iowa State Univ., Iowa City). Radiation Botany, 4: 347-53(Dec. 1964). (COO-1024-12)

Air-dry and presoaked (hydrated 10 hr on filter paper moistened with 10^{-3} molar KNO_3) seeds of Arabidopsis thaliana, race Estland were exposed once to 250 KVP x radiation; exposures ranged from 1 to 1000 Kr. Exposures of 150 and 60 KR resulted in germination of only 50 cer cent of the air-dry and presoaked seeds, respectively. No effect on the requirement of an exposure to light during germination was detected in any of the irradiated groups of X-1 seeds. The light requirement had apparently been fixed in the X-1 seeds prior to the time of irradiation; the genetic and somatic changes produced in the X-1 seeds by irradiation did not modify that requirement. Among the X-2 progeny of presoaked seeds exposed to 1–10 kR, 14–20 per cent were light-indifferent. No mutants (light-indifferent) were detected among the X-2 progeny of seeds exposed to 1–20 kR in an air-dry condition. (auth)

15158 SOME EFFECTS OF X RAYS ON ROOT PRIMORDIA IN THE POPLAR. J. G. Scandalios (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 4: 355-9 (Dec. 1964).

A series of experiments were conducted utilizing various doses of x rays and a variety of indoleacetic acid (IAA) treatments in an attempt to determine the effect of these factors on the growth and emergence of roots from stem cuttings of the Lombardy poplar. When cuttings were exposed to x-ray treatments ranging from 0 to 10,000 R, and placed in darkness, it was found that the average number of roots produced per cutting varied inversely with the dose. Doses of 4000 R were found to give approximately 50 per cent inhibition, and doses ranging between 8000 R and 10,000 R produced almost complete inhibition in most experiments. Exogenous application of IAA was found to modify the response of this biological system to ionizing radiation. Treatment of cuttings with 4000 R alone resulted in more inhibition (84%) than if 4000 R was given before or after IAA treatment (33%). (auth)

15159 THE USE OF X RAYS IN INVESTIGATING POTATO CHIMERAS. H. W. Howard (Plant Breeding Inst., Cambridge, Eng.). Radiation Botany, 4: 361-71(Dec. 1964).

Evidence from chimeras suggests that in potatoes there are at the stem apex two layers, L I and L II, which are genetically independent, but there is probably not an L III which remains distinct from L II. In tubers, the skin (periderm plus phelloderm) is formed from a phellogen which arises mainly in the epidermis. The constitution of a potato chimera can be determined to some extent from its phenotype, from its breeding behavior and from the results of eye-excision experiments. X-ray treatment is of special value in that it enables plants to be obtained which are homogeneous for L I of the original chimera. A suitable x-ray dosage is 3500 R applied to apical ends (1.5 cm thick) of tubers with sprouts about 4 mm long. From such treated apical ends more than one shoot may develop and thus complicate the interpretation of results. X-ray treatment gives at first many blind shoots with thick, deformed leaves. Later there usually develop normal shoots from which plants with tubers are produced. Some of these shoots have grown from new meristems which have been formed from single surviving cells of either L I or L II. The chimeras investigated were Red King (a bud-sport

from the variety King Edward VII produced by a mutation in L I), Bonte Furore and Bonte Urgenta (both also from mutations in L I), Muller's Purple sport (from a mutation in L II) and "yellow" Rode Star and yellow Urgenta (both from mutations in both L I and L II). From the Red King, Bonte Furore, Bonte Urgenta and Muller's Purple sports it was possible to obtain by x-ray treatment plants which were homogeneous for either L I or L II of the original chimeras. No changes occurred from x-ray treatment of the two sports which had mutations in both L I and L II. It is pointed out that the changes from splashed to white and from hidden-spotted to spectacled tubers, which occur after either x-ray treatment or eye-excision, are not evidence for the chimerical structure of splashed and hidden-spotted tubers. A review of results from x-ray treatment of plants other than potatoes shows that L I cells, in addition to cells of layers internal to L I, may survive and may produce whole new meristems. (auth)

15160 EFFECTS OF GAMMA RADIATION OF THE GAMETES, ZYGOTE AND PROEMBRYO IN NICOTIANA TABACUM L. M. Devreux and G. T. Scarascia Mugnozza. Radiation Botany, 4: 373-86(Dec. 1964).

In order to study the effect of ionizing radiations on Nicotiana tabacum zygotes, the rest period of which lasts about 48 hr, 1000, 2000 and 4000 R of gamma radiation from ^{60}Co were delivered in 4 and 16 hr. In addition, gametes before fusion and proembryos were irradiated with the same total exposure applied in 16 hr. Few histologic abnormalities during embryo development were ascertained. These, however, were always observed after an initial normal development of the embryo. From embryo growth analyses it was observed that, in most cases, the irradiations did not slow down the embryo growth rate, but rather increased it over control values, depending on the stages irradiated and the exposure administered. It was found that the increase in embryo size was related to a greater number of cells. However, a retardation in the rate of embryo development occurred in practically every treatment between the eighth and eleventh day after pollination. Clear differences have been found between the zygote irradiations delivered in 16 and 4 hr; the former generally induced a great damage to the developing embryo than the latter. Seed set was nearly normal in all treatments, except in the cases of 2000 and 4000 R delivered to the zygotes at low dose rates; weight of seeds and germinability decreased only after gamete irradiation with 4000 R; cotyledon abnormalities increased in all treatments with increase in exposure, the highest frequency occurring after proembryo irradiation (40 per cent with 4000 R) and the lowest after zygote irradiation at the high exposure rates. (auth)

15161 EFFECT OF CHRONIC GAMMA IRRADIATION IN DURUM AND BREAD WHEATS. B. Donini and G. T. Scarascia Mugnozza (CNEN, Rome). Radiation Botany, 4: 387-93(Dec. 1964).

Plants of different varieties of durum and bread wheats were subjected to several dose rates of chronic gamma irradiation for the whole of their life cycle or allowed to recover after 38 or 56 days of irradiation. In plants subjected to daily exposures of 148 and 72 R with or without a recovery period, the following growth reactions were observed: increase in the mean number of culms per plant; and increase in the mean weight per mature plant. In both durum and bread wheats the strongest tillering reaction was typical of the late varieties. Analysis of the number of spikes per plant showed that three out of the ten varieties tested formed spikes in greater number than the controls at 148 R/day chronic exposure; an increase in mean number of spikes per plant was observed in most of the varieties of 52 and 72 R/day. Spikelet fertility and germinability of seeds produced by irradiated plants showed that the group of bread wheat varieties, as a whole, is more radiation resistant than the group of durum wheat varieties. Among these, Aziziah appeared the most radiation sensitive, and Cappelli the most radioresistant. (auth)

15162 CHANGES IN PEROXIDASE ACTIVITY, ASCORBIC AND DEHYDROASCORBIC ACID CONTENT IN VICIA SATIVA GROWN UNDER CHRONIC GAMMA IRRADIATION. M. Giacomelli and T. Cervigni (CNEN, Rome). Radiation Botany, 4: 395-403(Dec. 1964).

Plants of Vicia sativa, chronically irradiated in the gamma field at exposure rates of 5.9, 12.6, 21.2 and 42.6 R/hr were analyzed periodically for modifications in peroxidase activity and ascorbic acid (AA) and dehydroascorbic acid (DAA) content. It was found that a remarkable increase in DAA content during the first 315 hr irradiation paralleled the growth depression induced by radiation; in the same period, the AA content was not affected by radiation. If irradiation lasted longer (up to 700 hr), there occurred a sharp decrease in the AA content and a still sharper decrease in the DAA content. This last reached very low values at 600 hr. Plants recovering after 375 hr chronic exposure did not show any visible difference with respect to those left under irradiation. However, changes in AA and DAA started to appear after 11 days recovery. In the control plants, peroxidase activity showed a peak at the end of the flowering period; in the irradiated plants the maximum occurred several days earlier. The suggestion was presented that chronic irradiation induced a kind of metabolic shortening of the life cycle. The possible correlations between growth reduction, auxin content and the biochemical parameters studied are discussed with reference to the effect of radiation on plants. (auth)

15163 SOME PHYSIOLOGICAL EFFECTS OF GAMMA IRRADIATION ON LEMON FRUIT. E. C. Maxie, I. L. Eaks, and N. F. Sommer (Univ. of California, Davis). Radiation Botany, 4: 405-11(Dec. 1964).

Gamma irradiation of lemon fruit at doses as low as 100 krads results in delayed but severe injury. After 30 to 40 days at 15°C (59°F) the fruits develop cavities along the segment walls. This injury apparently is not caused by dehydration even though irradiated fruits lose more water than do unirradiated fruits. Doses of 200 to 400 krads cause a dramatic loss in ascorbic and citric acids in juice extracted from lemon fruit after 40 days at 15°C. Radiation injury resembling the Black Button disease of citrus appears about two weeks after treatment, and Alternaria rot develops in the dying tissues. Auxin and kinetin treatments following irradiation did not protect the buttons from the injury. (auth)

15164 INHIBITION OF GEOTROPISM BY IONIZING RADIATION: REVERSAL OF THE INHIBITION BY AUXINS. T. W. Holmsen, H. J. Teas, and A. L. Koch (Univ. of Florida, Gainesville). Radiation Botany, 4: 413-16(Dec. 1964).

Intact Pisum sativum seedlings irradiated with doses up to 320 kR were markedly inhibited in their geotropic response. Inhibition of this response by certain levels of γ radiation was reversed by auxins. The radiation induced inhibition of the geotropic response of maize (Zea mays) coleoptiles was not reversed by any auxin application tested. (auth)

15165 EFFECT OF IONIZING RADIATION ON SEED GERMINATION AND SEEDLING GROWTH OF PINUS RIGIDA (MILL). Francois Mergen and T. Stroem Johansen (Yale Univ., New Haven and Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 4: 417-27(Dec. 1964). (BNL-7869)

Seeds of Pinus rigida (Mill.) trees were exposed to gamma irradiation while they were still in the cones on the trees. The trees were growing in a natural pine-oak forest that was irradiated by a ^{137}Cs (9500 curies) source. The vegetation was exposed to radiation during 20 hr each day, for periods ranging from a few days to six months, beginning on November 22, 1961. The exposures sampled ranged from 0.36 R/day to a level of 840 R/day, and for a total exposure of up to 22,700 R. After cone collection the seed was extracted, and the seeds were stratified for 4 weeks before they were germinated under controlled conditions. Up to an exposure rate of 130 R/day and for a total exposure of 16,000 R radiation did not affect germination. However, at an exposure rate of 295 R/day, germination was reduced after an exposure of 8000 R. The LD_{50} for seed irradiated at 840 R/day was approximately 22,000 R. There

was a temporary stimulation in root length and an increase in fresh weight of the seedlings at an exposure of 6000 to 8000 R, and a temporary retardation in overall growth at exposures above 8000 R. The weakened seedlings were subject to damage by microorganisms, but this could be checked by the use of a fungicide. There was an increase in the nuclear disturbances as a result of exposure, but there were normal mitotic divisions up to the highest level of exposure (22,700 R). The initial stimulation or retardation in height growth as a result of ionizing radiation had disappeared after the seedlings were one year old. After two growing seasons there was no statistically significant difference in height between irradiated seedlings and their controls. The high radiation tolerances that were observed can be attributed to the duration of the exposure, to the fact that mature seeds were irradiated in the cones and thus had not been damaged during extraction, to the beneficial effect of after irradiation stratification, and to the testing under optimal growing conditions. (auth)

15166 SEED EMBRYO FEATURES AND IRRADIATION RESPONSE. A. O. Lunden (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Radiation Botany, 4: 429-37(Dec. 1964).

Embryos removed from seeds of 12 plant species were thoroughly studied to obtain a better understanding of embryonic structure. Dose-response data, representing seedling development in controlled environment chambers following seed equilibration, γ-ray exposure, and planting in perlite-peat growth media, were obtained for each species. Data were collected on number of embryonic leaves and buds, volume of cells and nuclei in terminal apex promeristem tissue, volume of terminal apices, chromosome number, and exposure of ^{60}Co γ-radiation required to reduce seedling growth by 50 per cent. There was highly significant correlation between cellular and nuclear volumes and radiation tolerance (these were exponential functions). Multiple regression analysis of cell and nuclear volume on exposure tolerance gave estimates which were accurate within a factor of two while inclusion of nine embryonic factors gave estimates accurate within 10 per cent. The accuracy of dose predictions for other species will be tested. (auth)

15167 THE INFLUENCE OF SEED IRRADIATION WITH SMALL RADIATION DOSES ON THE DEVELOPMENT OF WHEAT AND BARLEY. A. Suess and A. Haisch (Bayerische Landesanstalt fur Bodenkultur, Pflanzenbau und Pflanzenschutz, Munich). Radiation Botany, 4: 439-53(Dec. 1964). (In German)

The problem of growth stimulation by small doses of radiation was studied in several crop species, irradiating the seeds and checking early stages of development. Irradiation caused significant variations in water uptake during soaking and in fresh weight and dry weight measurements of shoots taken after 14 days of growth. Germination also was influenced. No unit dose with maximum effect in all test reactions could be found. Effective doses were between 0.5 R and 100 R. Doses of more than 200 R were harmful to growth. No clear cut borderline between growth stimulation and retardation seen, since this line is quite variable, dependant on several partly unknown factors. Some experiments served to test whether the growth stimulating effect of radiation can be influenced. It was found that temperature is of major importance. At 20°C the radiation effect was less well expressed than at 10 and 15°C. Crop species variety was also important, but the influence of variety was not always statistically significant. Besides these factors the effect of varying the atmosphere (oxygen, nitrogen) when irradiating, as well as the effect of seed aging was studied. In both cases, an irradiation effect was statistically significant, but no correlation between irradiation and treatment could be proved. It was shown by means of analysis of variance that the radiation effect was reproducible from 1960 to 1963. Growth stimulation by small radiation doses was still highly significant in the F_1 progeny of the irradiated seeds. Among the different test reactions for growth stimulation, measurement of dry-weight of shoots proved especially useful. Using this criterium the differences mean values of doses came out better than if water uptake, shoot length and shoot fresh weight were considered. (auth)

15168 ANALYSIS OF RADIATION-INDUCED ELECTRON SPIN RESONANCE SPECTRA IN PLANT SEEDS. G. Loefroth, A. Ehrenberg, and L. Ehrenberg (Karolinska Institutet, Stockholm). Radiation Botany, 4: 455-67(Dec. 1964).

Radiation induced free radicals in seeds were studied by means of electron spin resonance. At least two classes of radicals are formed, one giving a narrow type absorption line and the other, which is most likely a doublet, giving a broad absorption. Concentrations of the two types of radicals can be estimated for any sample by a simple semi-empirical method, only involving the area and height of the integrated absorption. The yield and the change of concentration of the two radicals upon storage are shown to depend on the conditions during irradiation as well as storage. Possible correlations between the behavior of the induced free radicals and the biological damage together with the limitations of such estimations are discussed. (auth)

15169 RADIATION-INDUCED INCREASE IN LIFE EXPECTANCY IN A STRAIN OF YEAST. A. P. James and M. M. MacNutt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiation Botany, 4: 469-78(Dec. 1964).

The anomalous reaction of a respiratory-deficient strain of Saccharomyces cerevisiae to uv irradiation. Individual lines of this strain became moribund after reproducing for a variable number of cell generations on a medium normally considered optimal. The progression toward extinction could be halted by exposure of cells to uv light. Six influences were found which mimicked the effect of irradiation. These were: a reduction of nutrients in the culture medium; mutation; substitution of galactose for dextrose in the culture medium; an increased temperature of incubation; a decreased temperature of incubation; and a spindle poison, mercaptoethanol. In each case the increase in life expectancy of the strain was accompanied by a reduced rate of cell division. By analogy, the beneficial effect of irradiation was attributed to the inhibition of mitosis. It was considered that this inhibition permitted the accumulation of an essential substance which would otherwise be depleted and lead to cell death. The nature of this substance remains to be determined, but results indicated that its production is relatively unaffected by irradiation. (auth)

15170 RADIORESISTANCE IN CRUCIFERS. C. Gomez-Campo and L. Delgado (Instituto Nacional de Investigaciones Agronomicas, Madrid). Radiation Botany, 4: 479-83(Dec. 1964).

A survey of forty-seven species of crucifers after dry seed irradiation shows that a high proportion (twenty-eight) have an LD_{50} over 80 kR, seventeen of them range from 40 to 80 kR, and only for two species (Hesperis matronalis L. and Matthiola incana R.Br.) is the LD_{50} under 40 kR. Nuclear volume and chromosome size are among the most probable factors to account for such radioresistance, though the existence of chemical protection by normal seed constituents should not be discounted. The inhibition of seed germination still needs much higher exposures which are not clearly correlated to the doses reducing plant survival. Acute irradiation of seedlings and chronic irradiation of growing plants have also been carried out with demonstrative but limited results. (auth)

15171 OCCURRENCE OF AN INHIBITOR IN WHEAT ENDOSPERM AS REVEALED BY EMBRYO TRANSPLANTATION IN IRRADIATED SEEDS. P. Meletti, C. Floris, and F. D'Amato (Universita, Cagliari, Italy and Universita, Pisa, Italy). Radiation Botany, 4: 497-502(Dec. 1964).

Seeds (caryopses) of durum wheat var. Cappelli were soaked in water for 24 hr at 20°C to soften them enough for excision of embryos with scutellum. After irradiation of half of the soaked seeds (2 to 10 kR of x-rays), embryos were excised from both irradiated and unirradiated seeds and the following transplantations were made: unirradiated embryo on irradiated endosperm, $EM_{(u)}/EN_{(i)}$, and unirradiated embryo on unirradiated endosperm, $EM_{(u)}/EN_{(u)}$ (homotransplant, to serve as control). In 1962 and 1963,

using seeds of the crops of 1961 and 1962 respectively, it was demonstrated that endosperms of after-ripened seeds stimulated growth in the $EM_{(u)}/EN_{(i)}$ seedlings. Evidence was found that this stimulatory effect results from the destruction (or inactivation) by radiation of an inhibitor present in the endosperm of after-ripened seeds. The inhibitor is not present, in detectable amounts, in the endosperm of seeds during the total period of dormancy (first three months or more after harvest). The results are discussed in relation to the general problem of growth responses, including stimulation, in irradiated seeds. (auth)

15172 RADIOBIOLOGICAL STUDIES IN PLANTS. X. MUTATION RATE INDUCED BY IONIZING RADIATIONS AT THE AL LOCUS OF SAND OATS. Ichizo Nishiyama, Sadao Ichikawa, and Etsuo Amano (Kyoto Univ.). Radiation Botany, 4: 503-16(Dec. 1964).

In order to elucidate a relationship between radiation dose rate and somatic mutation rate, a mutant line of sand oats known as green inconstant, heterozygous for plant color gene (+/al), was used. Dry seeds of the green inconstant were exposed to neutrons from a reactor and gamma rays from ^{60}Co or ^{137}Cs. All of the doses were simultaneously measured with several appropriate dosimeters at every irradiation treatment. Distinct white stripes were found in leaf 3–6 of seedlings, but those in leaf 1 and 2 were too small and indistinct to score. All induced stripes in leaf 3–6 extended from the base to the apical part of leaf blades and remained the same width throughout. The number of white stripes per leaf and the average ratio (p%) of white stripe width to leaf width were used as criteria of the somatic mutation frequency by radiation treatments. It was evident that the frequencies of white stripes increase with dose in each leaf, and the dose-response relationship does not appear to be linear, especially in the gamma treatments. Dose-rate effects were also observed, the higher dose rate being more effective. These responses are explicable by assuming a combination of one-hit and two-hit events. On the other hand, the frequencies of white stripes were reduced successively from leaf 3 to 6. This phenomenon seems mainly to be due to the developmental pattern of plant, and partly to elimination of mutant cells. Based on a consideration of leaf ontogeny it was concluded that the average ratio (p%) of white stripe width to leaf width in leaf 3 shows more approximate value of the mutation rate at the al locus than those in leaf 4 to 6. (auth)

15173 WATER CONTENT OF WHEAT AND BARLEY SEEDS AND THEIR RADIOSENSITIVITY. R. Biebl and I. Y. Mostafa (Universität, Vienna) and Seibersdorf Reactor Center, Austria). Radiation Botany, 5: 1-6(Mar. 1965).

Wheat and barley seeds were allowed to attain different water contents by soaking or keeping in desiccators of known vapor pressures. Seeds were then exposed to 20 kR of either x or γ rays. Seedlings were grown in filter paper rolls for 10 days and the reduction in height (expressed as percentage of control) was used as a criterion for assessing immediate damage of radiation. An optimum water content, at which the radiosensitivity of seeds reached its minimum, was found to be around 11.2 and 12.9% for barley and wheat respectively. While in case of soaked seeds the radiosensitivity increased below and above the optimum water content, desiccator seeds on the other hand showed a sensitivity increase below, but not above the optimum. This increase in sensitivity above the optimum water content in case of soaked seeds might be due to changes in metabolic activity accompanying the rapid changes in water content during soaking. (auth)

15174 TOLERANCE OF PINUS RIGIDA TREES TO A TEN-YEAR EXPOSURE TO CHRONIC GAMMA IRRADIATION FROM COBALT-60. A. H. Sparrow, L. A. Schairer, and G. M. Woodwell (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 5: 7-22(Mar. 1965). (BNL-8404)

The Brookhaven Gamma Field was established primarily to expose cultivated plants to chronic gamma irradiation from cobalt-60. However, after about 7 growing seasons, injury to the native Pinus rigida trees bordering the cultivated field became apparent at exposure rates as low as 5 R/20 hr day. Detailed observations of these trees were started in 1958 and cumulative exposures and average daily exposure rates (obtained by dividing the cumulative exposure by the number of exposure days) were calculated for trees in 10-meter arcs around the source. Cumulative and daily exposures varied from year to year since periods of exposure and the size of the source were not constant. Source size varied from 145 to 3950 effective curies. Radiation injury was expressed in terms of mortality, growth inhibition, and reduced seed set. Tree mortality was recorded in May of 1960 and subsequently in each August through 1963 and survival curves plotted for a population of about 500 trees. By the end of 1960 (8 years of exposure) 50 per cent of the trees had been killed by a cumulative exposure of 5.8 kR (3.1 R/day) but a few trees survived exposure rates as high as 10 R/day. Further radiation injury accumulated after 1960 so that by August of 1962 about 20 per cent of the trees had been killed by as little as 5.0 kR at about 2.5 R/day and at an average exposure rate of 3 R/day, totalling about 7.4 kR, 50 per cent mortality occurred. No trees survived cumulative exposures above 13 kR. These lethal exposures are much higher than those reported in other species of pine after acute irradiation. The effect of long-term radiation on tree growth was measured as a reduction in radial enlargement of the trunk and as reduction in needle length. Xylem increments, measured after several years' exposure at less than 4 R/day, were reduced in the upper part of the tree and in some cases completely missing at the base of the tree. The irradiated cambial cells which had produced no xylem increment during several years of poor growth retained the capacity for producing new xylem in favorable years. Reduced growth of needles proved to be a good sublethal index of radiation damage. Slight growth inhibition could be observed at average rates as low as 1.5 R/day on trees which had received a cumulative ten-year exposure of about 3.6 kR and 50 per cent growth inhibition occurred at about 3 R/day. Reproductive processes were affected at low exposure rates also. The number of mature seeds per cone was reduced to about 10 per cent of the control value after an average exposure of about 3.5 R/day or a cumulative exposure to the tree of 7.4 kR for a nine-year period. No seed-bearing cones were formed above about 7.4 kR cumulative exposure. Unpublished data on interphase chromosome volumes of gymnosperms suggest that this species of pine should be fairly typical of the genus with respect to radiation sensitivity. Other genera of gymnosperms are also expected to have relatively high sensitivities but none is expected to exceed this genus by more than a factor of about 2. (auth)

15175 CYTOLOGICAL EFFECTS OF IRRADIATED GLUCOSE. J. Moutschen and R. Matagne (Universite, Liege). Radiation Botany, 5: 23-8(Mar. 1965).

Onion and barley root tip cells were treated with solutions of glucose ^{60}Co γ irradiated with doses ranging from 0.05 to 79 Mrad. The interference produced by environmental conditions (such as low pH induced by γ-rays) could be controlled. A nucleotoxic effect due to irradiated glucose was observed. Chromosome aberrations were found to be induced, although at a low rate as compared with the effects of ionizing radiations or mutagenic chemicals on the same materials. Chromosome aberrations mainly consisted of iso-locus breaks, a majority of which were localized at the centromere. No dose-effect relationship could be demonstrated for the investigated doses. Some genetical implications of the cytological effects are discussed. (auth)

15176 THE EFFECTS OF GAMMA-IRRADIATION AND STORAGE TEMPERATURE ON THE GROWTH, FLOWERING AND BULB YIELD OF WEDGEWOOD IRIS. A. H. Halevy and J. Shoub (Hebrew Univ., Rehovot, Israel). Radiation Botany, 5: 29-37(Mar. 1965).

Wedgewood iris bulbs were kept in common storage, at 25°C, or subjected to 5 weeks of cold storage at 13°, at the beginning or at the end of storage period. Bulbs were irradiated with cobalt-60, γ-irradiation (100 to 1500 R) at

various stages of bud development. Irradiation of cooled bulbs accelerated flowering by up to 21 days. A radiation dose of 500 R accelerated flowering by 13 days without reducing flower stem length, when applied at a very early stage of bud growth (one week after beginning of cold storage). Irradiation at a later stage did not stimulate flowering. A few of the irradiated flowers were abnormal. All flowers were normal, and no acceleration of flowering was noted in bulbs grown for the second year after irradiation. A slight stimulation of leaf and bulb growth was found with low irradiation doses applied to retarded bulbs (stored at 25°C). Foliage length and bulb yield were progressively reduced by increasing doses of radiation. Irradiation was more detrimental to cooled bulbs than to common storage or 25°C-stored bulbs. (auth)

15177 GERMINATION OF PINUS RIGIDA SEEDS AFTER GAMMA IRRADIATION. EFFECTS OF POST-IRRADIATION TREATMENTS, MOISTURE CONTENT AND INDIVIDUAL TREES. F. Mergen and J. Cummings (Yale Univ., New Haven and Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 5: 39-51(Mar. 1965). (TID-20958)

The effects of environmental factors, particularly moisture content and storage treatment, on responses to gamma irradiation were studied in seeds of Pinus rigida Mill. The variable germination results obtained with commercially purchased seed indicated a need for close control of conditions before and during experiments. Techniques were developed for uniform collection and treatment of seeds from trees growing in the natural pitch pine-oak forest at the Brookhaven National Laboratory, Upton, New York. To study the effect of exposure rate and post-irradiation treatment on germination, samples of seeds were exposed to ten total exposures (0 to 48 kR) at two exposure periods (16 and 80 hr). After irradiation, seeds were either sown immediately or stored for four weeks at 4°C under dry or moist conditions. Moist stratification caused an increase in germination that was paralleled by a decrease in cytological damage at all exposure levels, but there was no difference between the exposure periods within any post-irradiation treatment. The nature of recovery after irradiation was studied using a 16-hr exposure period, five total exposures (0 to 24 kR) and six stratification periods (0 to 6 weeks). Stratification decreased the radiation effect, and the recovery period at lower levels of radiation was shorter than at higher levels. Stratification increased germination at all radiation levels but not the rate of seedling development. Samples were equilibrated for eight days at six moisture contents (2.4 to 16.1%) and exposed for 16 hr to five exposures (4 to 36 kR). Increased moisture content up to 8.9% decreased the radiosensitivity, and between 10.9 and 16.1%, LD_{50} values for germination were similar (20 to 21 kR). In this range there was no loss of germination capacity up to 12 kR, although seedling development was retarded. Recovery increased with increasing stratification period and moisture content. Using a 16-hr exposure period and a total exposure of 5 kR, there were significant differences in seed germination between ten trees and within individual trees. Seeds from the upper crown were generally more sensitive to gamma rays than those from lower positions. The variation in radiosensitivity was not related to differences in seed size. Throughout the paper, the LD_{50} values that are reported deal with germination percentages. (auth)

15178 RADIOSENSITIVITY IN MAIZE SEED INFLUENCED BY CYTOPLASMIC FACTORS. J. R. Edwardson (Florida Agricultural Experiment Station, Gainesville). Radiation Botany, 5: 53-9(Mar. 1965).

Reactions of eight corn hybrids to ^{60}Co gamma radiation were examined by comparing height means of seedlings arising from irradiated seed. Twelve sources of variation which produced significant F values were obtained in analysis of variance of seedling height means. Differences in seedling heights suggest that fertility restorer genes may exert an influence on radiosensitivity. At 30 kR hybrids containing cytoplasmic sterility factors in T type cytoplasm were significantly taller than hybrids containing normal cytoplasm. The nature of the cytoplasmic elements responsible for the reduction in radiation damage in hybrids containing T type cytoplasm is unknown; these elements are not necessarily the sterility factors. In order to elucidate the nature of these cytoplasmic elements, sterility factors and the remainder of the plasmon must be studied separately for their possible influence on radiosensitivity. Methods of achieving this separation are discussed. (auth)

15179 COMPARISONS OF TRITIATED THYMIDINE, TRITIATED WATER, AND COBALT-60 γ-RAYS IN INDUCING CHROMOSOMAL ABERRATIONS. William C. Dewey, Ronald M. Humphrey, and B. Ann Jones (Univ. of Texas, Houston). Radiation Res., 24: 214-38(Feb. 1965).

Hamster cells growing in vitro were chronically irradiated with either ^3HTdR incorporated into the DNA, ^3H_2O contained in the medium, or γ rays delivered from a ^{60}Co teletherapy source. After either 10 or 23 hours of continuous irradiation, the cells were fixed, and the number of breaks and exchanges were scored in metaphase cells. For all three radiations, 20 to 40% of the aberrations were attributed to exchanges, all of which were of the chromatid type. For both ^3H_2O and ^{60}Co the aberration frequency was related to the 1.8 to 1.9 power of the dose; whereas for ^3HTdR the relationship approached linearity. To produce 2 visible aberrations per cell after irradiation over a 10-hour period, the following doses were required: 3500 disintegrations or 820 Rads to the nucleus from ^3HTdR, 1780 disintegrations in the nucleus or 490 Rads from ^3H_2O, and 520 Rads from ^{60}Co γ rays. The amount of chromosomal damage for a given dose of irradiation was less if the radiation was administered over two cell cycles (23 hours) instead of over one cell cycle. The average nuclear radiation dose from ^3HTdR was calculated to be 0.23 Rad per disintegration by assuming that the ^3HTdR was uniformly distributed throughout the nucleus with a radius of 4.0μ. The dose to the DNA if it was located in a 0.5-μ shell at the periphery of the nucleus was calculated to be 0.30 Rad per disintegration. On the basis of energy absorbed in the nucleus or chromosomes, the β-particle from ^3HTdR was less effective for producing chromosomal aberrations than the β-particle emitted either from ^3H_2O distributed in the nucleus or from γ rays absorbed in the cell. Energy absorption in or near the chromosomes was primarily responsible for producing aberrations, and the transmutation process in ^3HTdR was relatively ineffective for inducing aberrations. In the cells chronically irradiated by ^3H_2O or ^{60}Co γ rays during the S and G_2 periods, many of the breaks remained open for an hour or more. (P.C.H.)

15180 SURVIVAL OF MICE UNDER DURATION-OF-LIFE EXPOSURE TO γ-RAYS. II. PATHOLOGIC EFFECTS. Samuel Lesher, George A. Sacher, Douglas Grahn, Katherine Hamilton, and Anthony Sallese (Argonne National Lab., Ill.). Radiation Res., 24: 239-77(Feb. 1965).

A series of experimental groups of equal numbers of male and female LAF_1 mice were exposed to duration-of-life ^{60}Co γ irradiation. The following daily dose levels were used: 5, 12, 24, 32, 43, 49, and 56 R, plus a large group of nonirradiated controls. Animals were observed until death at which time they were examined for the presence of tumors or degenerative diseases in an attempt to define the cause of death. The two lower daily dose levels, 5 and 12 R/day, were far more carcinogenic than doses above this level. Although the incidence of most tumors was increased at 5 and 12 R/day, duration-of-life exposure was less carcinogenic per Roentgen of accumulated dose than are single and terminated exposures. The reduction in over-all tumor frequency at higher dose levels could be due to the earlier death or in part to a possible therapeutic effect as the dose level increases. Incidence and variety of tumors were much higher in the females, owing for the most part to their high lymphoma incidence and to tumors associated with the reproductive system. Lymphoid, pulmonary, and mammary tumors appeared earlier in the irradiated mice, whereas hepatomas, ovarian tumors, and the degenerative diseases nephrosclerosis and amyloidosis are not affected. Amyloid disease was higher among the males and appeared to be

more prevalent during the mid-life span. Multiple tumors were common in mice at the lower doses, reaching 50% among the 5-R/day females. (auth)

15181 AMINO ACID EXCRETION IN HUMAN PATIENTS ACCIDENTALLY EXPOSED TO LARGE DOSES OF PARTIAL-BODY IONIZING RADIATION. (THE LOCKPORT INCIDENT). Frank M. Ganis, Malcolm W. Hendrickson, and Joe W. Howland (Univ. of Rochester, N. Y.). Radiation Res., 24: 278-91(Feb. 1965).

Six technicians accidentally exposed to partial-body radiation while servicing a Klystron tube at a radar installation were hospitalized for medical observations. Several 24-hour urines were collected and frozen. After thawing, the urines were desalted and analyzed for amino acids by paper chromatography A qualitative and semiquantitative analysis revealed an increased aminoaciduria with particular abnormality in the excretion of cystine, proline, and tryptophan in four of the six technicians. (auth)

15182 FUNCTIONAL ALTERATION OF VISUAL RECEPTOR UNITS AND RETINAL PIGMENTS BY X-IRRADIATION. William W. Dawson and Herman Wiederwohl (Army Medical Research Lab., Fort Knox, Ky.). Radiation Res., 24: 292-304(Feb. 1965).

Single functional visual receptor units from the compound eyes of forty Limulus polyphemus were examined for visible light and x-ray phosphene responses similar to those previously reported in electroretinogram studies of the whole vertebrate retina. Doses of x-rays many times those required to produce the ERG phosphenes or retinal surface potentials were ineffective in reducing the level of dark adaptation. However, reduced light response latency and reduced light threshold were consistently observed during x-ray exposure. Extracts and suspensions of retinal material prepared from the eyes of frogs (Rana catesbiana) were examined spectrophotometrically, during and after irradiation. No wavelength shifts of the peak optical density were seen that might indicate the alteration of the extracts or formation of photoproducts during irradiation. Increases in density consistently followed x-ray exposures of magnitudes up to 500,000 times as great as the ERG x-ray phosphene threshold. (auth)

15183 EFFECTS OF X-IRRADIATION ON THE INJURY REACTION IN LENS EPITHELIUM. Clifford V. Harding, Mildred N. Thayer, Pamela A. Eliashof, and Roberts Rugh (Columbia Univ., New York). Radiation Res., 24: 305-11 (Feb. 1965).

Experiments indicated that a small mechanical injury to the anterior surface of the rabbit lens can result in a stimulation of tritium-labeled thymidine incorporation (an indication of DNA synthesis) and mitosis in many epithelial cells surrounding the site of injury. This stimulation (injury reaction), which starts at approximately 12 to 14 hours after injury, moves in wavelike fashion slowly outward from the site of injury. X irradiation at the beginning of the experiment, shortly after injury, inhibits the development of the injury reaction. Partial inhibition is evident after doses of 200, 500, and 1000 R. The threshold for complete suppression of the injury reaction is approximately 1500 R. There was no evidence that x irradiation under these experimental conditions will inhibit the development of the wave of mitosis without inhibiting development of the wave of stimulation of thymidine incorporation. Irradiation at the end of the experiment, just before the injection of tritium-labeled thymidine (at a time when the injury reaction has become well established), inhibited mitosis without blocking thymidine incorporation. (auth)

15184 AN AUTORADIOGRAPHIC AND BIOCHEMICAL STUDY OF THE EFFECTS OF RADIATION ON DEOXYRIBONUCLEIC ACID SYNTHESIS IN THE INTACT ANIMAL. W. B. Looney, L. O. Chang, S. S. Williams, J. Forster, I. C. Haydock, and F. W. Banghart (Univ. of Virginia, Charlottesville). Radiation Res., 24: 312-23(Feb. 1965). (TID-21109)

A study of the effects of localized irradiation on DNA synthesis in the intact animal was made by irradiating regenerating rat liver during the first cycle of DNA synthesis after partial hepatectomy. The irradiation dose range was from 750 to 40,000 R of x radiation. Changes in the total DNA content and the incorporation of labeled thymidine into DNA in the total population of cells after irradiation were assessed by biochemical methods. Changes in the rate of incorporation of labeled thymidine into DNA in individual cells and the per cent of cells synthesizing DNA were assessed by quantitative autoradiographic methods. There was a rapid depression of DNA synthesis in the lower dose range. Increasing amounts of irradiation resulted in smaller depression of DNA synthesis. The results of this and other studies suggest that the eventual depression of DNA synthesis is the result of the effects of irradiation on different steps in the biosynthetic pathway. Interference with phosphorylation is implicated in the initial rapid depression of DNA synthesis after irradiation. Higher doses of irradiation cause either complete inhibition of DNA synthesis or immediate cell death in some cells. (P.C.H.)

15185 SENSITIVITY TO ULTRAVIOLET RADIATION OF VESICULAR STOMATITIS VIRUS DURING REPLICATION IN CHICK EMBRYO CELLS. David Pittman, Isaac L. Schechmeister, and Ralph C. St. John (Southern Illinois Univ., Carbondale). Radiation Res., 24: 337-49(Feb. 1965).

The ultraviolet sensitivity of vesicular stomatitis virus-chick embryo cell complexes during the latent period of virus development is described. Procedures were developed so that complexes could be maintained in suspension rather than as monolayers for sampling and irradiation during the latent period. Radiation at those doses employed to inactivate complexes had no effect on the capacity of cells to support plaque formation by nonirradiated virus. The results show that the virus undergoes two phases of radiosensitivity during replication in chick embryo cells. The first phase occurs early in the eclipse or latent period and is characterized by exponential inactivation and increased sensitivity of complexes. The second phase occurs during the mid and late eclipse phase and is characterized by multihit inactivation of complexes. This phase is interpreted to mean that more than one viral entity must be hit to inactivate a complex. A working model, based on the notion that viral nucleic acid is the vulnerable radiation target, is put forward to explain the observed pattern of ultraviolet sensitivity of complexes during virus replication. (auth)

15186 RESPONSE OF WILD RODENTS TO ACUTE GAMMA RADIATION. Frank B. Golley, John B. Gentry, Edward F. Menhinick, and James L. Carmon (Univ. of Georgia, Athens). Radiation Res., 24: 350-6(Feb. 1965).

Four species of adult wild mice—Peromyscus polionotus, P. gossypinus, Reithrodontomys humulis, and Mus musculus—native to the Atomic Energy Commission Savannah River Plant area were subjected to an acute whole-body dose of γ radiation in the laboratory. The $LD_{50(30)}$ of the Cricetid rodents was between 1100 and 1200 R, about double that of Murid Mus musculus, which received the same experimental treatment and dose. Wild and domesticated Mus musculus did not differ in their response to irradiation. It was concluded that real differences between families of rodents had been observed and not differences due to treatment effects before or after irradiation. (auth)

15187 A TWIN-TUBE 50-KVP BERYLLIUM-WINDOW X-RAY UNIT FOR MICROBIAL RADIOBIOLOGY. Robert Loevinger and Pieter Huisman (Stanford Univ., Palo Alto, Calif. and Stanford Univ., Calif.). Radiation Res., 24: 357-67(Feb. 1965).

An x-ray unit suitable for irradiation of thin, flat samples in the laboratory at dose rates between 10^4 and 10^5 Rads/min, depending on sample thickness, is described. Sample holders can be altered as needed, and the x-ray beams can be either horizontal or vertical. Gas can be flowed over or through the sample during irradiation. Calibration is carried out by a combination of ionization and chemical dosimetry. (auth)

15188 INVERSE MUTATIONS IN AUXOTROPHIC MUTANTS OF E. COLI B/r. M. N. Myasnik. Radiobiologiya, 4: 836-9(1964). (In Russian)

Escherichia coli B/r mutants produced by x or uv irradiation, which require tryptophane for growth, are differen-

tiated by the frequency of spontaneous mutations, the lag in their appearance, and the rate of growth on the medium, the frequency varied from 0 to 28.5. A lag was observed in mutants 5UF and 90R but not in 25R and 52P. There was no correlation between lag and growth rate. The irradiation mutants appeared to be heteroallele. (IIC-M.G.)

15189 CYTOGENETIC RADIOSENSITIVITY OF MARROW CELLS OF MICE OF DIFFERENT AGES. O. A. Sysoeva. Radiobiologiya, 4: 843-6(1964). (In Russian)

The radiosensitivity of mouse bone marrow cells changed on irradiation (25 to 100 R) with increasing age of the animals. The radiosensitivity of marrow from 10- and 12-day-old animals differed very little, but that from 3-month-old animals was approximately 1.5 times lower than in the 10- and 12-day animals irradiated to 100 R. (IIC-M.G.)

15190 MITOTIC INDEX OF BONE MARROW AND ^{59}Fe RED CELL INCORPORATION AFTER IRRADIATION IN RATS. D. Mechali, M. Taranger, S. Ledermann, and F. Godiniaux (Commissariat a l'Energie Atomique, Paris). Rev. Franc. Etudes Clin. Biol., 9: 829-38(Oct. 1964). (In French)

Hematopoiesis was studied in rats after cobalt-60 irradiation at doses of 100, 200, 300, 500, 644, 700, and 720 Rads. An attempt was made to correlate irradiation dose with marrow injury by two methods. The erythrocyte and granulocyte series mitotic indexes were determined three days after irradiation using four rats for each dose, with 10 controls serving to establish the normal values. At the 500 Rads dose ($\frac{1}{3}$ of the 30 day LD_{50}) the mitotic indexes were studied for 28 days after irradiation. Red cell incorporation of ^{59}Fe was observed after injection 3 days after irradiation in 8 rats compared with 8 controls, with blood activity measured 4 days after injection. Both methods showed that the greater the irradiation dose the more severe the depression of marrow activity. The mitotic index gave a wide scatter of results due to individual variation, whereas ^{59}Fe incorporation gave more homogeneous results and showed a direct relationship of marrow depression to dosage. The phenomenon of marrow stimulation by small doses of irradiation is discussed. (auth)

15191 CHANGES IN SEVERAL HEPATIC ENZYMO-METABOLIC INDEXES IN ANIMALS WITH EHRLICH ASCITES CARCINOMA. F. De Luca (Universita, Pavia, Italy). Riv. Patol. Clin., 18: 383-8(Aug. 1963). (In Italian)

Sixteen mice were inoculated with Ehrlich ascites carcinoma, and five to 12 days later 12 animals were irradiated for six days with a daily dose of 50 R of 150-kv x rays in the abdominal area. The animals were sacrificed on the tenth, 12th, and 14th days after inoculation, and liver homogenate and slices prepared for microspirometric study, oxygen consumption and anerobic glycolysis being tested by the Warburg method. Two days postirradiation the oxygen consumption already was significantly below normal and decreased further on the tenth day, but showed higher values than the unirradiated controls. The values became normalized on the 12th and 14th days. Anerobic glycolysis showed distinctly increased values until the end of the x-ray therapy and normalized afterwards. A marked decrease, which began early and continued progressively, was observed in glutamic-oxalacetic transaminase and glutamic-pyruvic transaminase activity. Malic dehydrogenase showed a similar behavior, and lactic dehydrogenase clearly deviated from the norm four days after inoculation. On the tenth day the enzymes showed increased values in comparison to the controls and then returned to normal. Aldolase activity showed increased values on the second day, on the tenth day also was increased in comparison to the controls, and then normalized. The ascites carcinoma alone produced hepatic enzymatic and metabolic imbalance, as seen by the decreased oxygen consumption that was partly compensated by the increased glycolytic activity, as well as the marked and progressive decline in the transaminase activity. It is evident that the parenchymal hepatic metabolic disorder caused by the tumor impairs protein synthesis by the liver. The x-ray therapy appeared to destroy the tumor at least partially and temporarily. The eventual regression of the hepatic biochemical changes following the x-ray therapy confirms the interrelation between tumor growth and hepatic metabolic alterations. Evidently the tumor destruction achieved through x-ray therapy is capable of improving and normalizing the metabolic disorder caused by proliferation of malignant cells in the liver. (BBB)

15192 GRANULOCYTE ANOMALIES AS AN EXPRESSION OF DESTRUCTION AND REGENERATIVE PHASES OF RADIOINDUCED BONE MARROW INJURY. R. Stodtmeister and Th. M. Fliedner (Stadtische Krankenhaus Pforzheim, Ger.). Schweiz. Med. Wochschr., 94: 1401-2 (Sept. 26, 1964). (In German)

Whole-body irradiation of rats with 800-R doses of high-speed electrons (15 Mev) resulted in a massive disturbance of granulocytopoiesis with maximum depression of granulocyte formation on the 3rd day. In marrow smears, abnormalities due to mitotic disorders were initially observed in mature granulocytes 24 hr after irradiation, and became numerous after 48 hr. The atypical granulocytes were characterized by their abnormal size and the quantity of nuclear material present. The size distribution of granulocytes was determined by photographic planimetry, and it was found that as a result of radiation damage the area of giant granulocytes may reach three times the normal values. The changes suggest mitotic disturbances in the regenerating cells. The chromatin structure of these giant cells was only rarely altered, the main change being a pyknotic swelling. It was concluded that the origin of the chromatin changes of the neutrophilic granulocytes in the regeneration phase is in nuclear injury of the stem cells since practically all of the granulocytes in the regeneration phase are newly formed from the stem cells. (BBB)

15193 CHANGES IN RESPIRATORY CONTROL INDEX OF IRRADIATED MITOCHONDRIA. Fu-yu Yang and Jinzhao Li. Sci. Sinica (Peking), 13: 2026-9(Dec. 1964).

Changes in respiratory control index and p/o value of rat liver mitochondria exposed to x rays in vitro were studied for doses to 7×10^4 R. The Mg^{++} and DNP-stimulated ATPase activities were studied at the same time. (R.E.U.)

15194 IONIZING RADIATION: EFFECT OF IRRADIATED MEDIUM ON SYNTHETIC PROCESSES. Ernest C. Pollard, Marlin J. Ebert, Carolyn Miller, Kathryn Kolacz, and Thomas F. Barone (Pennsylvania State Univ., University Park). Science, 147: 1045-7(Feb. 26, 1965).

The incorporation of uracil-^{14}C into macromolecules in Escherichia coli cells was decreased by doses of ionizing radiation when the cells were in very dilute suspension. The decrease resulted from an action of irradiated medium on the cells, and a similar reaction was observed during the incorporation of thymine (indication of DNA synthesis) and of proline and valine (indicative of protein synthesis). Irradiated medium reduced the formation of β-galactosidase but did not cause the degradation of DNA. (auth)

15195 THE EFFECT OF CHRONIC ^{60}Co GAMMA IRRADIATION ON THE TESTES OF THE ALBINO RAT. I. EFFECT OF THE SYNTHESIS OF NUCLEIC ACIDS. Chandra K. Parekh and Sidney O. Brown (Cornell Univ., Ithaca, N. Y.). Texas J. Sci., 16: 365-75(Sept. 1964).

Weanling male Holtzman albino rats received doses of 10 R per day over a 23-hr period from a ^{60}Co source. At the end of 10 days, one group of animals had received 100 R, and later groups at the end of 20 days (200 R), 30 days (300 R), 40 days (400 R), and 50 days (500 R) after radiation initiation. The testes of the irradiated animals exhibited a significant reduction in weight when subjected to a whole-body dose of 300 R or higher, and histological manifestations of typical radiation injury to the testis were discernible above 300 R whole-body dose. The DNA content (μg/mg) also increased significantly over that of the control animals following a whole-body dose of 100 R. After 200 and 300 R the DNA concentrations in the testes showed no significant difference from that of the same age control animals, but after 400 and 500 R the DNA concentrations were significantly decreased. RNA concentrations, as μg/mg of testicular tissue decreased similar to that observed for DNA concentrations. Likewise an increase in the RNA,

μg/mg of tissue, was observed after 100 R and was significantly higher than that of the controls. RNA concentrations of animals receiving 200 R showed no significant difference, but after a total accumulated dose of 300, 400, and 500 R the RNA tissue concentrations showed dose-dependent decreases. It was concluded that changes in RNA content following chronic irradiation are similar to that observed in DNA following 100 R, and that there is a significant increase in RNA concentration in the testes of the irradiated animals as compared with that of the control. With increasing accumulation of chronic doses of 300 R and above, enzyme systems become inactivated, resulting in decreased phosphorylating activity of the organ and in decreasing synthesis of RNA in testes. (TCO)

15196 INFLUENCE OF TEMPERATURE ON THE RADIATION DAMAGE TO THE LUCIFERASE-LUCIFERIN SYSTEM AND COLLAGEN. C. F. Fowler (Univ. of Arkansas, Little Rock). Texas Rept. Biol. Med., 22: 777(1964).

Ionizing radiation is thought to form reactive molecular species that diffuse and modify molecules in aqueous solutions and solids. Temperature variations would be expected to effect the diffusion of these reactive species and consequently modify the radiation effect. To study this hypothesis the enzyme system luciferase-luciferin and collagen were used. Aqueous solutions of the enzyme were x irradiated at temperatures ranging from −20 to 30°C and the luminescent activity measured. Collagen samples were irradiated with x rays at −195°C and stored at temperatures ranging from −195 to 100°C for 2 hr. The decay of paramagnetic centers produced by the radiation was measured using an electron spin resonance instrument. It was found that radiation damage could be held latent at temperatures below 0°C. This could be attributed to the trapping of reactive species in ice, thus blocking their diffusion to important molecules. (BBB)

15197 FURTHER STUDIES ON RADIATION-INDUCED SENSITIVITY OF HAMSTER CELLS TO TRANSFORMATION BY POLYOMA VIRUS. Michael Stoker (Univ. of Glasgow). Virology, 24: 123-5(Sept. 1964).

In an attempt to select radiation-resistant and transformation-sensitive cells, BHK21 clone 13 cells from hamsters were exposed to three cycles of irradiation to a survival of 2.5%, with intervening propagation. The final population of cells was neither more resistant to x irradiation nor more sensitive to transformation, and it showed the usual enhanced sensitivity after further irradiation. This did not rule out the possibility that selection of genetic variants was responsible for the original phenomenon because radiation-resistant and transformation-sensitive cells might be lost by overgrowth of surviving normal cells during the cycles of propagation. To investigate the effect further, the time relation between irradiation and infection was studied. Monolayer cultures of BHK21/clone 13 cells were infected with 1.3×10^9 plaque-forming units of polyoma virus before or after irradiation with 500 R of x rays, and the cells were plated on irradiated mouse fibroblast feeder layers for identification of normal and transformed colonies. When irradiation was delayed for 24 hr after infection, an increase in transformation frequency was observed in the surviving cells similar to that found when cells were irradiated immediately prior to infection. The sensitivity to transformation remained high for two days after irradiation and fell to normal or low values after four days, indicating that the increased sensitivity to transformation persisted for at least two days. After the surviving cells began to divide, however, the sensitivity was lost. It was concluded that the increased sensitivity to transformation is due to direct action of irradiation on the cells. (TCO)

15198 THE EPIDEMIOLOGY OF URINARY TRACT INFECTIONS IN HIROSHIMA. Lawrence R. Freedman, John P. Phair, Masafumi Seki, Howard B. Hamilton, and M. Dean Nefzger (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Yale J. Biol. Med., 37: 262-82 (Feb. 1965). (TID-21419)

A simple method for obtaining a semiquantitative estimate of the number of bacteria in a clean voided midstream urine specimen was used to screen a study group of about 3,000 women and 2,000 men living in Hiroshima City. Infections were much more common in women than in men and rose with age in both sexes. The greatest increase in the prevalence of infections found in women age 60 years and over was due to coliform bacteria in all but a few instances. Comparison of women under and over 60 years did not reveal any differences in the type of bacteria recovered from the urine or their resistance to antibiotics. Reasons are given for concluding that the increased rates of infection in women age 60 or more were due to increased susceptibility rather than to an altered course of infections. Symptoms of urinary infection, proteinuria, and pyuria were more common in infected women as compared with noninfected women. Mean blood pressure levels were significantly higher in women with infection than in the noninfected. The difference between the clinical rates of urinary infection in men and women and the pathological diagnosis of pyelonephritis in the patients drawn from the same population supports a previous suggestion that much of what is called pyelonephritis at autopsy is not due to urinary tract infection. (P.C.H.)

15199 THE EPIDEMIOLOGY OF DIABETES MELLITUS IN HIROSHIMA AND NAGASAKI. Lawrence R. Freedman, William G. Blackard, Leonard A. Sagan, Morihiro Ishida, and Howard B. Hamilton (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Yale J. Biol. Med., 37: 283-99(Feb. 1965). (TID-21423)

Data are presented on the finding of glycosuria and the diagnosis of diabetes mellitus during four years of a long term study of the health of population samples of Hiroshima and Nagasaki. Diabetes and glycosuria are much more common in Hiroshima than in Nagasaki and in both cities these findings are more frequent in males than in females. The prevalence of diabetes appears to be increasing in Hiroshima males. Findings in diabetics were compared with nondiabetics. In general, Japanese diabetics are similar to diabetics in other countries concerning their increased risk of obesity, hypertension, proteinuria, hypercholesterolemia, and cardiovascular and cerebrovascular diagnoses. This is of particular interest in the light of evidence that ketosis and severe abnormalities of carbohyrate metabolism are rare in Japan as compared to Western countries. Despite a lower prevalence of diabetes in Japanese females than in males, the abnormalities associated with diabetes appear to occur more commonly in female diabetics than in male diabetics. (auth)

15200 A BRIEF NOTE ON THE TARGET THEORY. H. Eisenlohr (International Atomic Energy Agency, Vienna). Z. Naturforsch., 19b: 1159(Dec. 1964).

It is demonstrated, using a simple example, that an exponential dose effect relation may also be obtained by a suitably chosen relation between the number of hits and the test effect within a target, which is subdivided into equal subvolumes. (P.C.H.)

15201 FURTHER STUDIES ON RHESUS MONKEYS IMMUNIZED AGAINST SCHISTOSOMA JAPONICUM BY ADMINISTRATION OF CERCARIAE OF THE FORMOSAN STRAIN. S. Y. Li Hsu and H. F. Hsu (State Univ. of Iowa, Iowa City). Z. Tropenmed. Parasitol., 14: 506-12(Dec. 1963).

Experiments on rhesus monkeys immunized against S. japonicum by administration of cercariae of the nonhuman strain and x-irradiated cercariae of the human strain were carried out. The cercariae of the nonhuman Formosan (F) strain were newly shed from the snail Oncomelania formosana, and the cercariae of the human Japanese (J) strain were shed from the snail O. nosophora. The x-irradiated cercariae were of the J strain exposed to 1700 R before inoculation. Rhesus monkeys immunized with cercariae of the nonhuman F strain showed strong protection against subsequent challenge with the human strain. The effect of immunization was good with two immunizing inoculations and still better with three to five inoculations. The effect of six to eight inoculations did not cause an additional improvement. A uniformly effective immune result against challenge infection was achieved in monkeys which received, in addition to previous inoculations with cercariae of the F

strain, either a last immunizing inoculation of male and female cercariae of the J strain which had been exposed to 1700 R, or a last inoculation of nonirradiated male cercariae of the J strain. A theory of dual immune antibodies was proposed. The acquired immune effect in monkeys immunized with cercariae of the F strain lasted for at least 717 days. Even in monkeys well immunized with the cercariae of the F strain, a few mature male and female worms originating from the challenge infection were seen at autopsy. Thus these worms had escaped the immune effect produced by the schistosomulic stage of the F strain and might not be further influenced by the anti-schistosomulic antibodies in these monkeys, indicating that the host needs a different kind of antibody to combat the adult worms. The stunted mature worms developed from the cercariae of the J strain exposed to 1700 R of x irradiation or from the male cercariae of the J strain may produce such an anti-adult immune body. (BBB)

15202 PREDPOSEVNOE OBLUCHENIE SEMYAN SEL'SKOKHOZYAISTVENNYKH RASTENII. (Pre-Sowing Irradiation of Agricultural Seeds). N. M. Berezina. Moscow, Atomizdat, 1964. 210p.

A literature review (800 references, half Russian) is presented on the history of the first studies on the action of ionizing radiation on seeds. Radiosensitivity of plants and its variability are discussed, and work on presowing irradiation of seeds is reviewed for plants of agricultural importance, e.g., vegetables, grains, fiber plants (linen, cotton, jute, etc.), and oil and essential oil plants. (IIC-M.G.)

15203 VLIYANIE IONIZIRUYUSHCHIKH IZLUCHENII NA TSENTRAL'NUYU NERVNUYU SISTEMU. (Effects of Ionizing Radiation on the Central Nervous System). P. F. Minaev. Moscow, Izdatel'stvo Akademii Nauk SSSR, 1962. 132p.

A literature review (225 Russian, 105 non-Russian) is presented. Phases of the subject discussed are: methods of study; clinical, physiological, biochemical, and morphological observations; significance of the condition of the nervous system; and the nature of radio-induced changes in the tissues. (IIC-M.G.)

15204 PERVICHNYE RADIOBIOLOGICHESKIE PROTSESSY. (The Primary Radiobiological Processes). M. I. Amiragova, N. A. Dyzhenkova, A. V. Savich, and M. I. Shal'nov. Moscow, Atomizdat, 1964. 288p.

General information on primary radiobiological processes (49 references) is presented, and the effect of radiation on nucleic acids (243 references), porphyrin compounds (200 references), and on amino acids and proteins (183 references) are discussed. (IIC-M.G.)

15205 SIMILARITIES AND CONTRASTS BETWEEN RADIATION AND TIME PATHOLOGY. George W. Casarett (Univ. of Rochester, N. Y.). p.109-63 of "Advances in Gerontological Research. Vol. I." New York, Academic Press, 1964.

A critical evaluation is presented on the various criteria used in comparing the pathology of time and irradiation, in terms of one another, namely, the criteria based on mortality, specific diseases, morphology, and physiology (including biochemistry). Operational definitions are briefly discussed. The general considerations of acturial, pathological, histo-pathological, and physiological changes following irradiation, in comparison with the manifestations of normal aging, indicate a strong qualitative resemblance between the permanent and late effects of life-shortening whole-body irradiation and the manifestations of premature aging, although qualitative differences seem to exist and quantitative factors are not always equivalent or proportional. 180 references are included. (P.C.H.)

15206 SUGARBIOLOGIA. (Radiobiology) Erzsebet Kalman, Laszlo Sztanyik, Umil Unger, and Vilmos Varteresz. Budapest, Medicina, 1963. 498p. (In Hungarian)

Information is included on the fundamental principles of radiation physics and dosimetry, the theories of the primary processes, radiation biochemistry, metabolism, morphology of the biological effects of radiation, radiation sensitivity and resistance, pathological action, radiation syndrome and therapeutic methods, genetic problems, carcinogenic effects of radiation, toxicology, and protection against radiation. 44 pages of references are included. (TTT)

15207 GENERAL EFFECTS OF NUCLEAR WEAPONS WITH NOTES ON DEFENSE PROBLEMS. Harry H. Haight and Robert D. Jordan. p.48-85 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The general effects of nuclear weapons are reviewed with emphasis on medical aspects. The effects of blast, trauma, thermal radiation, ionizing radiations, and fallout are considered. Data on the effects of 20 KT nuclear bombs on the populations of Hiroshima and Nagasaki are reviewed and an attempt is made to extrapolate these effects to those of kiloton bombs. Data from nuclear weapons tests are also reviewed. Data are tabulated on the ranges in miles of certain bomb effects of medical interest for 1 KT, 10 KT, 100 KT and 1 MT bombs. It is postulated that the ability of the people of the United States to survive a nuclear attack will depend largely on advance preparations. The importance is stressed of adequate warning and shelter systems. (30 references.) (C.H.)

15208 FUNDAMENTAL BIOLOGY OF IONIZING RADIATIONS. Friedrich Ellinger. p.128-37 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

A survey of the accumulated data on the effects of ionizing radiations on living matter reveals that certain common features exist in the response of cells and tissues to radiation regardless of whether they are of the electromagnetic type, like x and γ rays, or corpuscular radiations, like α, β, neutron, or proton rays. It also appears that these effects of irradiation are qualitatively the same, whether the source of rays is outside the body or within. These common features in the response of cells and tissues are understood easily if the various phenomena called radiations are viewed under the single concept of energy and considered as a stimulus, capable of influencing living matter in such a way that it is modified in the course of its vital functions. The general manifestations of radiations on living matter are summarized as to ways of action, time and effect, quality of effects, and quantity of effect. Topics discussed include the primary effects of radiation in biological systems, morphological effects, functional effects, mechanisms of action, recovery phenomena, factors affecting the radiosensitivity of cells and tissues, and the response of tumors to radiation. (C.H.)

15209 THE PATHOLOGICAL ANATOMY OF TOTAL-BODY IRRADIATION. John L. Tullis. p.138-69 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Biological response to ionizing radiation depends on energy transfer within the tissue, and the physical characteristics of the radiation make little or no qualitative difference in the tissue reaction. There are marked quantitative differences in biological responses that are dependent upon the specific ionization patterns, or density, of the radiations, the size of the dose, the dose rate, the size of the field irradiated, and other factors. Data are reviewed on the pathological effects of whole-body irradiation with large doses in man and experimental animals. Topics discussed include anatomic lesions, specific lesions, the relation of symptoms to lesions, delayed effects of exposure to radiation, diagnosis of radiation injuries in relation to pathology, and lesions resulting from radioactive fallout. (84 references.) (C.H.)

15210 THE HEMATOLOGY OF IONIZING RADIATION. Eugene P. Cronkite, Victor P. Bond, and Robert A. Conard. p.170-202 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Changes that are induced within blood and blood-forming organs by acute and chronic exposure to ionizing radiations are reviewed. Topics discussed include mechanisms of injury, changes in peripheral counts, sensitivity factors, variations in number and morphology of blood cells, ra-

dioinduced leukemia, factors influencing the effect of ionizing radiation, the detection of radiation injury by hematological procedures, the evaluation of blood changes, the hemorrhagic syndrome of radiation illness, the value of hematological studies in acute radiation injury, and the relation of the hematopoietic system to survival in radiation injury. (125 references.) (C.H.)

15211 DIAGNOSIS AND THERAPY OF ACUTE RADIATION INJURY. Eugene P. Cronkite, Victor P. Bond, and Robert A. Conard. p.238-50 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964. (BNL-6680)

The practical aspects of the diagnosis and treatment of acute whole-body radiation injuries are discussed for the situation following a single accident in which a very small number of individuals are involved and the problems expected in the event of nuclear warfare. Topics discussed in detail include the diagnosis of radiation injury following criticality accidents, therapy under ideal conditions, the criteria for the classification of radiation injuries resulting from nuclear warfare, and the management of radiation injuries in nuclear warfare. (28 references.) (C.H.)

15212 FALLOUT RADIATION: EFFECTS ON THE SKIN. Robert A. Conard, Eugene P. Cronkite, and Victor P. Bond. p.281-302 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Lesions of the skin induced by fallout are primarily due to the β radiation from fission products adhering to the fallout material. Serious radiation injury is only associated with fallout situations where the radioactive material is sufficiently concentrated. The importance of this hazard was demonstrated in 1954 when a large group of people of the Marshall Islands was accidentally exposed to fallout radiation following the experimental detonation of a large nuclear device. The chemical and physical characteristics of fallout material are described and the sources of radiation from fallout are reviewed. Methods of estimating β doses to skin from fallout are discussed. The acute and chronic effects of fallout radiation on the skin are described. Precautionary measures for reducing skin exposure to fallout are obtained. (66 references.) (C.H.)

15213 RADIATION DAMAGE IN UTERO. Shields Warren. p.303-10 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Data are reviewed from a number of studies in experimental animals on the effects of radiation on fetuses and embryos in utero. Available data on the mortality and pathology of infants whose mothers were exposed to diagnostic or therapeutic irradiation or to the effects of the atomic bombs at Hiroshima and Nagasaki are summarized. It is concluded that exposure of the developing embryo to ionizing radiation may cause abortion, malformation, or possibly leukemia in the infant. The dose required for obvious injury is over 100 R in man. Radiation injury sustained late in fetal life is less harmful than early exposure when organogenesis and differentiation are more active. Fetal central nervous system, eye, and mesenchymal tissues appear to be more radiosensitive than those of adults. Secondary placental damage due to sequelae of irradiation of the mother may cause abortion. (C.H.)

15214 ORAL EFFECTS OF RADIATION AND FEATURES OF IMPORTANCE IN DENTISTRY. James A. English. p.679-95 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The effects of radiation on the teeth and oral tissues are reviewed. The pathogenesis of oral lesions induced by Ra is described. Protective measures for patients, dentists, and technicians during the diagnostic use of x-ray machines by dentists are outlined. (76 references.) (C.H.)

15215 R.B.E. OF PROTONS AND ALPHA PARTICLES. J. W. Haffner (North American Aviation, Inc., Downey, Calif.). 36p. (CONF-720-20)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The RBE-LET (relative biological effectiveness-linear energy transfer) relationship was used as a starting point for an analytical investigation into the RBE of protons and alpha particles. Charge acquisition was handled explicitly and nuclear interactions implicitly in the study, which yielded analytical expressions for the RBE of protons and alpha particles. The expressions simplify considerably above the critical energies where the RBE = 1. The critical energies are 10.8 Mev for protons and 249 Mev for alpha particles. Continuous energy spectra of the E$-\alpha$ type were also treated. Comparisons with experimental data are presented. (auth)

15216 RADIATION STUDIES ON LENTICULAR EPITHELIAL ENZYMES IN YOUNG X-IRRADIATED RABBITS. A. A. Swanson (Veterans Administration Hospital, McKinney, Tex.). 21p. (CONF-217-5)

From Radiation Research Society 11th Annual Meeting, Milwaukee, May 1963.

Lenticular mitochondria and soluble fraction from six week old New Zealand white male rabbits exposed to 800 R whole-head x irradiation were evaluated for glucose 6-PO_4 dehydrogenase, TPN isocitrate dehydrogenase, malic dehydrogenase, glutathione reductase, glyceraldehyde 3-PO_4 dehydrogenase, nucleoside phosphorylase, diaphorase, and NAD cytochrome c reductase. Increased enzyme values were noted in the irradiated lenticular tissues for nucleoside phosphorylase, diaphorase, and NAD cytochrome c reductase. Decreased glucose 6-PO_4 dehydrogenase, malic dehydrogenase, glutathione reductase, and glyceraldehyde 3-PO_4 dehydrogenase values were detected in lenticular tissues from irradiated animals. TPN isocitrate dehydrogenase did not change in either group studied. (auth)

15217 HEMO-AGGLUTININ RESPONSE OF ISOLOGOUS SPLEEN CELLS IN IRRADIATED MICE THYMECTOMIZED IN ADULT LIFE. Giovanna Agarossi (CNEN, Casaccia, Italy) and Gino Doria. 12p. (CONF-717-17)

From CNRS Meeting on Graft of Allogenic Hematopoietic Cells, Paris, Sept. 1964.

A quantitative study was carried out on the adoptive immunity by isologous spleen cells in lethally irradiated mice thymectomized in adult life. Spleen cells from normal donors or donors immunized to sheep RBC were injected into thymectomized and nonthymectomized irradiated mice, which also received the test antigen. Primary or secondary agglutinin production by the transferred spleen cells was measured in the recipient sera. Titration data showed that both primary and secondary responses to sheep RBC were thymus-independent. This result is at variance with what was previously found for adoptive immunity by bone marrow cells. The role of the thymus in the cytokinetics of antibody production will be discussed. (auth)

15218 HAEMATOLOGICAL STUDIES UPON MOUSE RADIATION CHIMAERAS. A. M. Cross, A. J. S. Davies, O. Rosiek, and P. C. Koller (Royal Cancer Hospital, London). 13p. (CONF-717-18)

From CNRS Meeting on Graft of Allogenic Hematopoietic Cells, Paris, Sept. 1964.

The rate of hematopoietic recovery after irradiation was examined in mice in which the lymphoid system was either depleted by thymectomy before irradiation, or increased by implanting thymus grafts immediately after irradiation. In thymectomized syngeneic BALB/c → BALB/c chimeras, no differences could be detected in the rate of recovery of the myeloid and erythroid components of the hematopoietic system. However, in allogeneic CBA → BALB/c chimeras, implanting three CBA neonatal thymus grafts increased the mean speed of recovery of the myeloid, erythroid, and lymphoid cells of the bone marrow. After 30 days most of the chimeras with thymus grafts were in better condition than those without, but there were still a few mice which were wasting, and in these the thymus grafts were absent or in poor condition. At early times (up to 30 days after irradiation), splenomegaly and mortality were greater in allogeneic chimeras with thymus grafts than in those with no grafts. It is suggested that the presence of thymus grafts accelerates the graft-versus-host reaction after the injection of alloge-

neic bone marrow, but that once this initial reaction has subsided the effect of thymus grafts is beneficial. (auth)

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Refer also to abstracts 15274 and 15275.

15219 (NP-14805) GLYCIDIC ESTERS AND/OR ORGANIC DISULFIDES, AND RELATED SUBSTANCES, AS SOURCES OF ANTI-RADIATION DRUGS. Annual Progress Report No. 3, October 1, 1963–September 30, 1964. Including Interim Research Report No. 20 for July 1, 1964–September 30, 1964. L. Field, R. B. Barbee, J. D. Buckman, H. K. Kim, W. B. Lacefield, and T. F. Parsons (Vanderbilt Univ., Nashville, Tenn.). Contract DA-49-193-MD-2030. 28p.

Twenty-two compounds were submitted to the Walter Reed Army Institute of Research for screening as anti-radiation drugs. In the main, these were thiolsulfonates, aminodisulfides, sulfinic acid derivatives, and dithiocarbamyl derivatives. The structures of the materials were established, and their stabilities and general chemistry were investigated. Studies also were made on mercapto disulfides, dithiosulfites, and cyclic disulfides. The reaction of thiolsulfonates with thiols was the principal means for synthesis of the aminodisulfides. Several of the drugs were active in protective capability against ionizing radiation. (auth)

15220 IMPORTANCE OF THE SPLEEN IN THE TUMOR FORMATION AFTER IRRADIATION. K. Gross (Institut Oncologique, Prague) and B. Schober. Acta Unio Intern. Contra Cancrum, 20: 1564-7(1964). (In French)

Although the incidence of tumors in the first series amounts to about 40% in rats having spleen and only to 15% in those without spleen and though in the second series absence of tumors was observed, the results were not always statistically significant. Interesting was the statistically significant difference in the incidence of tumors in male and female rats. It is, however, necessary to pay attention to the fact that, on the average, rats with multiple tumors survive a longer time. (auth)

15221 EFFECTS OF TELECOBALT RADIATION ON THE BLOOD VESSELS OF THE NECK. Giuseppe Cardinali and Giuseppe Lovino (Universita, Modena, Italy). Arch. Ital. Otol. Rinol. Laringol., 74: 46-61(Jan.-Feb. 1963). (In Italian)

Adult rabbits were divided into a control group, pyridoxine-treated group, and prednisolone-treated group. The animals were irradiated on the anterior-lateral neck region with ^{60}Co γ radiation over a field of 4 × 4 cm at total focal doses of 4000, 5000, and 6000 R. The control animals divided into three groups received total mean doses of 4056, 5148, and 6048 R (maximum doses 4520, 4640, and 6786; number of sessions 8, 12, and 26; number of treatments 10, 15, and 30). The animals injected intravenously with vitamin B_6 and prednisolone, in single doses, respectively, of 10 mg and 0.5 mg for each kg, and total vitamin B_6 doses of 250, 357, and 750 mg, and prednisolone 12.5, 18.7, and 35.5 mg (days of treatment 10, 15, and 30; doses 4056, 5148, and 6048 R). Some control animals were sacrificed immediately after treatment and others 15 days afterwards. The vitamin B_6- and prednisolone-treated animals were sacrificed at the end of treatment. Histological examination of the control irradiated animals showed marked submucosal edema in the trachea, hyperemia of the capillary vessels, congestion of large vessels, edema of the connective tissues, and other damage. In the tissues of the vitamin B_6-treated animals the tracheal submucosal edema was markedly decreased. Larger vessels showed the absence of subendothelial cell structural changes. The endothelial and smooth muscular structures were normal. The prednisolone group showed histologic findings that were more or less the same as seen in the controls. Thus pyridoxine showed a therapeutic effect following telecobalt radiation while the cortisone-type steroid did not produce similar beneficial results. (TCO)

15222 STUDIES OF THERAPEUTIC EFFECTS OF MARINAMYCIN FOR LEUKOPENIA IN IRRADIATED RABBITS. Momoe Soeda, Mamoru Mitomi, Hirokuni Ozawa, and Yoshiaki Fukazaw. Boei Eisei, 9: 399-402 (Sept. 1962). (In Japanese)

The effects of the antitumor antibiotic marinamycin on radioinduced leukopenia, due to destruction of the hematopoietic tissues with x rays, were studied. In rabbits exposed to 182 R the outstanding hematologic change seen was leukopenia; no other consistent changes in the hemogram were observed. Hence, only peripheral white blood cell counts were done as indexes of protective and therapeutic effects throughout the experiment. Marinamycin was injected intravenously into the rabbits three times at intervals of a week. They were then each exposed to 182 R twice at intervals of 16 days, and the white blood cell counts were checked for 80 days once or twice a week. It took 10 days for the white blood cell count to return to normal. In the control group of rabbits exposed to 182 R without marinamycin injection, 73 days were required for the white cell counts to return to normal. The rabbits exposed to 182 R once and given 3 to 4 intravenous injections of marinamycin (10 mg) 2 to 5 days later, promptly regained their normal white cell counts. (BBB)

15223 EFFECT OF CHLOROTHIAZIDE ON CESIUM-137 EXCRETION IN HUMAN SUBJECTS. Joan Harrison and K. G. McNeill (Univ. of Toronto). Can. Med. Assoc. J., 89: 1266-9(Dec. 21, 1963).

The therapeutic value of chlorothiazide in reducing the body burden of ^{137}Cs following accidental contamination was studied. Since it is likely that some time would elapse before any form of treatment could be started following accidental exposure, the diuretic was administered one hr after a single dose of radiocesium was ingested by two normal male subjects. Each ingested less than 0.1 μC of ^{137}Cs by mouth and, an hour later, were started on chlorothiazide at a dose of 2.0 g per day in divided doses for a total of three days. After two weeks, the chlorothiazide was repeated for a further three days. The total-body ^{137}Cs activity was measured with a whole-body counter, the intensity of the 0.66-Mev γ ray being measured with a 5-in. NaI crystal and a 100-channel pulse height analyzer. There was no significant difference either in the amount of Cs excreted in the urine or in the percentage of Cs retained in the body between the subjects treated with chlorothiazide and the controls. Even at 10 months after Cs intake there was no significant change in Cs excretion with chlorothiazide. The effects of chlorothiazide on other urine and serum electrolytes were also studied. Urine K was increased 1.5 to 2 times the control values throughout each three-day period on diuretic; Na, Cl, and urine volumes were increased the first day and returned to near control values by the third day. All electrolytes showed a period of compensatory retention after chlorothiazide was discontinued. Serum K was decreased 20% after three days of therapy. Serum Na, Cl, and CO_2 combining power showed little change. The per cent retention of ^{137}Cs over a period of 320 days is shown. The biological half-lives were 90 and 155 days in the two cases. Not all the activity lost from the body was recovered. During the 10-day initial period, 50 to 70% of the amount excreted was recovered in the urine. Presumably most of the remainder is excreted by the gastrointestinal tract, since values for fecal ^{137}Cs-activity of 10 to 39% of total Cs excretion have been reported. The total body K was also measured by total-body counter, measuring the 1.46 Mev γ ray of ^{40}K. Cases one and two which had biological half-lives for Cs of 90 and 155 days, respectively, had K half-lives of 42 and 41 days. These results support the evidence of other research workers that Cs and K are not utilized interchangeably in normal biological systems. Although the two elements are related, the body has a greater binding capacity for Cs than for K. (BBB)

15224 ULTRASTRUCTURAL LOCALIZATION OF RADIATION PROTECTIVE DERIVATIVES OF S-(2-AMINO-

ETHYLTHIURONIUM BROMIDE HYDROBROMIDE IN RAT DORSAL ROOT GANGLION CULTURES TREATED AND IRRADIATED IN VITRO. Edmund B. Masurovsky and Richard P. Bungle (Columbia Univ., New York). J. Cell Biol., 23: 121A(Nov. 1964).

Electron microscope investigations of radiation effects on cultured nervous tissue showed that S-(2-aminoethyl)-thiuronium bromide hydrobromide (AET), in the 2-mercaptoethylguanidine (MEG) and bis(2-guanidoethyl) disulfide (GED) forms, afforded significant radiation protection to rat dorsal root ganglion cells treated and irradiated in vitro. Therefore, these cells offer a suitable biological system to study, by electron microscopic autoradiography, the ultrastructural binding sites of the protective SH and SS groups of these AET derivatives. Cultures of rat dorsal root ganglia, in which neuronal maturation and myelination had occurred in vitro, were treated for 20 min before irradiation with buffered balanced salt solution, pH 7.4, containing 3 mM ^{35}S-AET. The cultures were x irradiated at a dose rate of 1000 R/min. Over 50% of the protective agents was taken up by the cells during the incubation and irradiation treatments, and relatively little was subsequently removed by the fixation, dehydration, and embedding procedures. Silver grains, marking thiol and disulfide binding sites, were observed over the nucleolus and nuclear matrix, and near the nuclear membranes of neuronal, satellite, Schwann, and various connective tissue cells. Within the cytoplasm, grains appeared over Golgi complex and mitochondrial regions as well as along the plasma membranes of most cells; granular endoplasmic reticulum and lysosome-like bodies were less frequently labeled. Thus, the important cellular binding sites of AET derivatives are in the vital nuclear, mitochondrial, and plasma membrane regions of cells. (BBB)

15225 A PRELIMINARY REPORT ON THE RADIOPROTECTING AND RADIOSENSITIZING EFFECT OF 8-METHOXYPSORALEN ON ALBINO RATS. Abdel Monem El-Mofty, M. Ali Motawi, and Salwa H. Topouzada (Cairo Univ.). J. Invest. Dermatol., 43: 149-50(Sept. 1964).

A study was made of the effect of 8-methoxypsoralen (8-MOP) on animals exposed to x and β radiation. Adult male albino Wistar rats were given 450, 600, 900, and 1200 R in a single exposure as a total-body irradiation. Beta emissions were generated from a ^{90}Sr plaque containing 50 mC emitting 400 rep/min. The shaved abdominal skin was exposed to graded doses of 2000 to 12,000 rep given to areas in two parallel rows. Survival rate, loss of hair, skin reactions, rate of appearance and disappearance of these reactions were used as indicators of radiosensitizing and radioprotective capacity of the drug. Rats which received 100 mg of 8-MOP in the diet 2 hr before irradiation survived graded doses of 600 to 1200 R. Rats receiving 100 mg of 8-MOP in the diet 2 hr before exposure to 900 R died after an average of 8.6 days while the control rats died after an average of 12.6 days. Giving the drug in daily doses of 0.33 mg, for 15 days before the exposure to irradiation of 900 R, caused death of rats after 6 days (controls survived for 12.6 days). This indicates that the radiolethality was more enhanced with small doses. Rats exposed to 1200 R, 2 hr after the ingestion of 100 mg 8-MOP, died after an average of 4 days, whereas the controls died after 8.6 days. The discrepancy between the results obtained with superficial x rays (90-kv) and with the more penetrating rays (230-kv), indicates that its sensitizing effect is the result of the drug's effect on deep-seated organs rather than through its effect on the skin. The study of the effect of 8-MOP on the skin reactions on exposure to graded doses of β radiation up to 1200 rep showed a radioprotective effect of the drug. The time of appearance of reactions was increased to 10 days on exposure to 2000 to 6000 reps (7 days in the control group). On exposure to larger doses—up to 12000 reps—the time of appearance of reactions was 7 days (3 days in the control group). (BBB)

15226 THE COURSE OF RADIATION SICKNESS AGAINST THE BACKGROUND OF THE SIMULATING ACTION OF RADIOPROTECTIVE SUBSTANCES ON THE HYPOPHYSIS-ADRENAL SYSTEM. V. E. Ryzhenkov and A. M. Stashkov (Inst. of Experimental Medicine, Leningrad). Med. Radiol., 9: No. 12, 46-50(Dec. 1964). (In Russian)

A significant rise in the 17-oxycorticosteroids concentration in the plasma of the peripheral blood and appearance of an eosinopenic reaction in dogs was noted 1 to 1½ hours after the administration of cystamine (50 mg/kg), unithiole (50 mg/kg), allylnoranthipheine (15 mg/kg), and phenatine (5.5 mg/kg). This testifies to an elevated functional activity of the hypothalamus-hypophysis-adrenal system. (auth)

15227 THE FFFECTS OF TYPHUS VACCINE ON THE REGENERATION OF RADIATION-DAMAGED RAT LIVER. Sarolta N. Sulyok, Endre Czeizel, and Pál Kertai (Staatliches Institut fur Hygiene, Budapest). Naturwissenschaften, 51: 540(Nov. 1964). (In German)

The effects of typhus vaccine on the regeneration of radiation-damaged liver were studied in albino rats, which had a partial liver resection. One group of rats received only typhus vaccine, one group was exposed to 500 R whole-body irradiation, one group was irradiated after receiving the typhus vaccine, and a last group was irradiated before receiving the typhus vaccine. The regeneration was measured on the 4th and 7th day. The results showed that x radiation inhibits liver regeneration. Typhus vaccine alone did not affect the extent of the regeneration, but it neutralized the regeneration-inhibiting effect of x radiation almost completely. Typhus vaccine applied after irradiation was ineffective. (J.S.R.)

15228 RADIOPROTECTION INDUCED BY BACTERIAL TOXINS. I. RADIOPROTECTION INDUCED BY BACTERIAL ENDOTOXIN IN X-IRRADIATED GERMFREE MICE. Taiju Matsuzawa (Univ. of Notre Dame, [Ind.]). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 242-5(June 1964). (In Japanese)

Germfree animals, devoid of micro-organisms, can be used in the study of radiation protection and recovery without the complications rising from animal microbial products. The LD_{50} x-ray dose for germfree Swiss-Webster mice is 720 R, whereas for their conventional counterpart it is 660 R. With administration of 20 μg S. typhosa endotoxin (lipopolysac-charide) i.p. 24 hours before x irradiation, the LD_{50} is elevated to 995 R for germfree mice, but only to 800 R for conventional mice. From this evidence, it is reasonable to presume that the radioprotection mechanism induced by bacterial endotoxin is correlated with immunological responses. Also it is thought that endotoxin radioprotection in both germfree and conventional mice is limited in the "hemopoietic death" range. (auth)

15229 ASSAY OF THE TRANSPLANTATION POTENTIAL OF BONE MARROW. Jerry P. Lewis (Presbyterian-St. Luke's Hospital, Chicago). Proc. Inst. Med. Chicago, 24: 227-34(May 1963).

Experiments designed to evaluate methods of assay of the transplantation potential of bone marrow are described. These studies were conducted to evaluate the efficiency with which in vitro tests of cellular viability predict the repopulating potential of marrow. In mouse survival studies, demonstration of the transplantation value of marrow was obtained by the protection it afforded lethally irradiated animals. A comparison was made of the protective effect of marrow stored in 15% glycerol at −196°C with that of fresh marrow. The test cell suspensions were injected intravenously into 14-week-old CAF_1 female mice two hr or less following 850-R whole-body irradiation (80 R greater than the LD_{100} dose). In experiments with over 700 mice the 50%-protective dose for both thawed and fresh cells was 30,000 cells. The technique of spleen colony assay is also described and results using this technique correlated well with the results obtained using mouse protection studies. Results obtained using three standard in vitro tests of cellular viability were compared to the actual repopulating potential of marrow as demonstrated by the two mentioned in vivo systems. The in vitro tests were found to provide no reliable estimate of a marrow's repopulating potential. The results are discussed in relation

to studies of preservation of human marrow in which in vitro tests have been relied upon exclusively for estimating efficiency of storage techniques. It was concluded that in vivo assay methods offer the only sound basis for comparison of the repopulating potential of one marrow suspension to another and of the protective effect of one storage technique to another. (TCO)

15230 PSYCHOTROPIC DRUG AND ADRENAL-PITUITARY INFLUENCES ON RADIATION-INDUCED CHANGES IN BRAIN ELECTRICAL ACTIVITY AND BEHAVIOR. W. R. Klemm and C. S. Bachofer (Univ. of Notre Dame, Ind.). Radiation Res., 24: 201-13(Feb. 1965).

X-Ray doses of 100 and 400 R produced aberrations in brain electrical activity and alterations of behavior in rabbits. The radioinduced changes occurred quickly after exposure and tended to persist for the 14 days of testing. Administration of two phenothiazine tranquilizers and two monoamine oxidase inhibitors prevented the changes ordinarily observed after irradiation. This effect was attributed, at least in part, to a drug-induced stress response involving adrenal-pituitary function. This conclusion was substantiated by several lines of evidence. The effects of radiation were less pronounced in intact animals than in partially adrenalectomized animals. All drugs caused a stress response. Psychotropic drugs failed to prevent radioinduced changes in partially adrenalectomized animals. Administration of the end product of a stress response (hydrocortisone) prevented radioinduced changes to a degree comparable to that observed when psychotropic drugs were employed. (auth)

15231 IONIZING RADIATION AND CHEMICAL PROTECTION. PART II. Francesco Toffoli. Rass. Chim., [16]: 137-41(May-June 1964). (In Italian)

The theory of the effects of ionizing radiation on water and on animal tissues is reviewed. The experiments, results, limitations, and theories on chemical protection are summarized. The most active substances in such protection are indicated, but they have only scientific importance, and not practical importance as yet. (tr-auth)

15232 USE OF ASPARA TABLETS FOR PROPHYLAXIS OF RADIATION SICKNESS. Toshio Araya and Hideo Wada (Univ. of Hokkaido, Sapporo). Sanfujinka No Shinpo, 15: 275-8(Sept. 1, 1963). (In Japanese)

Tests were made of K and Mg salts of aspartic acid as a prophylactic agent in preventing radiation sickness. A group of 14 ovarian and cervical cancer patients was given daily six Aspara tablets (each containing 75 mg each of K and Mg salts of aspartic acid) for the duration of radiation therapy with Ra or ^{60}Co. The patients were examined for hematologic changes, liver function, and general body condition before, during, and after radiotherapy. Comparative tests before and after therapy showed that the red blood cell count and the hemoglobin level did not vary; the white blood cell count showed a decline of an average of 600 (except two extreme cases of decline to ~3000/mm^3). The Westergren erythrocyte sedimentation rate showed 14 mm/hr; no change was seen in urinary protein level; and no change was seen in the urine urobilinogen test. Seven out of 14 cases showed no change in the bromsulfalein test of liver function, five showing a decline and two showing an increase in dye excretion (or an average decline of 1.8%). The Meulengracht jaundice index (serum bilirubin) showed no change. There was an average decline of 1.6% in total serum proteins (eight cases showing an increase, five a decrease, and one case no change). The Kunkel zinc sulfide serum protein lability test showed no appreciable variation, no values went beyond 12 units. It is concluded that liver function was not impaired as a result of the radiation therapy, except in two cases which showed a slight decline of liver function. Some subjective symptoms of radiation sickness were observed as follows: a few complained of decrease of appetite, fatigue, or lethargy to a moderate degree. None complained of nausea, vomiting, or dizziness; none had fever for more than a week. Two cases of loss of body weight were observed. (BBB)

15233 THE SELECTIVE ELIMINATION OF IMMUNOLOGICALLY COMPETENT CELLS FROM BONE MARROW AND LYMPHATIC CELL MIXTURES. I. EFFECT OF STORAGE AT 4°C. D. W. van Bekkum (Toegepast Natuurivetenschappelijk Onderzoek, Rijswijk, Netherlands). Transplantation, 2: 393-404(May 1964). (EUR-1356.e)

A test system was developed that permits the semiquantitative estimation of elimination rates of hemopoietic cells and immunologically competent cells in mixtures of the two cell types. The system involves the determination of complete cell dose-effect curves demonstrating the protective and killing effect of the two cell types in lethally irradiated mice. The inactivating effect of storage at 4°C was found to be more pronounced for immunologically competent cells than for hemopoietic cells, selectivity factors of 2.5–10 being obtained. It was found that unequivocal demonstration of selective elimination of this order of magnitude requires elaborate experiments because of the variations inherent in this type of test system. (P.C.H.)

15234 THE NATURAL HISTORY AND OUTCOME OF ANTIBIOTIC TREATMENT OF URINARY TRACT INFECTIONS IN WOMEN. Lawrence R. Freedman, Masafumi Seki, and John P. Phair (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Yale J. Biol. Med., 37: 245-61(Feb. 1965).

In four years of study on the late effects of ionizing radiation in Hiroshima, 159 cases of urinary tract infection were detected in women. Although the entire study population was not screened for urinary infection, the age distribution of patients with infections was similar to that found in surveys of the general population. Treatment was considered successful in about 84% of the cases when evaluation was based on follow-up cultures approximately three months after the administration of antibiotics. When evaluation was based on 18 months or more follow-up after treatment, only about 50% of the patients had negative urine cultures. The results were similar to those reported previously in hospital clinic patients. Observations on a small group of untreated patients suggest that for women, the long term result of gram-negative urinary tract infections is not significantly altered by a single short course of antibiotic treatment. (auth)

15235 USE OF THE PHENOTHIAZINE DERIVATIVE MAROPHEN FOR TREATMENT OF RADIATION SICKNESS AND FOR SYMPTOMS OF REACTIONS TO CONTRAST MEDIA. H. Reinhold and J. Bartels (Strahleninstitut and Strahlentherapeutische Klinik, Medizinische Akademie, Magdeburg, Ger.). Z. Ges. Inn. Med. Ihre Grenzgebiete, 18: 817-19(Sept. 15, 1963). (In German)

Reactions and disturbances of the autonomic nervous system are involved in the development of radiation side-effects and symptoms of reactions to contrast media. These side-reactions are a severe burden for patients and affect their status markedly. Phenothiazine druga, which exert direct effects on the central nervous system, are particularly suited for suppression of these autonomic reactions. The drug tested has no narcotic or sedative properties. The effectiveness of Marophen was studied in 50 patients who had been irradiated for gynecological disorders, mammary tumors, tumors of the neck, head or extremities, and bronchial or esophageal carcinoma. Of these, 44 showed no symptoms of radiation side-effects if they received one or two injections of Marophen. In 3 patients the radiation symptoms were markedly reduced by the treatment. The treatment was ineffective for only 3 of the irradiated patients. When Marophen was given only 30 min before the contrast medium, Biligrafin, no effects ordinarily observed with this material were seen. In 60 patients given adipiodone and treated with Marophen only one showed any symptoms arising from reaction to the contrast medium. When Marophen was administered both orally and intramuscularly, it prevented functional side-reactions in patients irradiated during depth therapy procedures. Only one patient was allergic to Marophen, and this reaction subsided quickly. No other side effects were observed. (BBB)

15236 SURGICAL PROBLEMS OF X-RAY INJURIES. P. Wilflingseder (Universitat, Innsbruck). Z. Klin. Med. 19: 11-16(Jan. 1964). (In German)

Considering the large number of irradiations that are carried out the number of injuries that require surgical treatment are relatively small. Source of radiation injuries is discussed. Indications for surgical intervention to repair x-ray injuries are deformity and interference with function, pain severe enough to compel the patient to consider operation necessary, precancerous changes, malignant degeneration, and tumor recurrence. If lesions of these types are not treated early enough the unavoidable surgical procedures necessary are ultimately made more difficult. Atrophic telangiectatic radiation scars should be replaced with healthy tissue. Surgical problems are complicated here for even when irradiated tissue appears healthy, with apparently normal circulation in the wound bed, unexpectedly extensive necrosis can occur postoperatively. Other factors, such as the increased susceptibility of irradiated tissue to infection and the relative lack of ability of irradiated tissue to proliferate also must be taken into account in planning surgical operations to repair radiation injuries. (TCO)

Radiation Hazards and Protection

See also HEALTH AND SAFETY.

15237 PROBLEM OF RADIATION PROTECTION IN RADIOSCOPY. Helmut Fendel (Universitat, Tubingen, Ger.). Aerztl. Forsch., 18: 486-91(Sept. 1964). (In German)

The exposition of patients to irradiation may be reduced in principle through television radioscopy, in the case of thorax radioscopy approximately in half, compared with screen radioscopy. In some examinations, for instance the abdomen, the possibility of such decrease is limited to start with. In order to achieve it in practice, a further improvement of the equipment will be needed. Also the examination technique must be adjusted to the new technical equipment. Under no means can a dose reduction be taken for granted; even in x-ray radioscopy a control of the dose to which the patient is to be exposed is strongly suggested. (auth)

15238 RADIATION PROTECTION FOR THE OPERATOR IN TV-FLUOROSCOPY. Heinz Ullrich (Siemens-Reiniger-Werke AG, Erlangen, Ger.). Aerztl. Forsch., 18: 522-5(Oct. 1964). (In German)

The possibilities of radiation protection in TV fluoroscopy through radiography intensification are discussed. Particular attention is paid to those appliances where the installation of an intensifier and TV emphasize the need for additional radiation protection. Mention is also made of instruments that have been specially developed for TV purposes in which the problem of radiation protection is a part of the whole. (auth)

15239 STRONTIUM-90 IN TEETH. Brit. Med. J., 2: 1411(Dec. 5, 1964).

The first comprehensive survey for ^{90}Sr in teeth of adult type was made in Britain using premolars from persons aged 9 to 13 yr, and third molars from persons aged 17 to 21 yr. The collection on a national scale was organized by the Dental Branch of the Royal Naval Medical School. The amounts of ^{90}Sr measured were low: the highest group mean was 0.90 pC/g Ca in premolars from 10-yr-old children extracted in 1962. The amount of ^{90}Sr in the teeth has been steadily increasing over the years in conformity with the increase in the total amount of fallout. The distribution of ^{90}Sr within a tooth provides a history of the levels of ^{90}Sr in the diet during the years when the tooth was calcifying. As a basis for monitoring environmental contamination, teeth are not exactly equivalent to bone, because the bones, but not the teeth, are in a state of continual mineral exchange with plasma. When dietary Sr is rising, levels in teeth will lag behind bone. When dietary Sr has been falling for a time the levels in teeth should become higher than in bone. However, it is possible to show real, if small, differences in the level of ^{90}Sr in teeth between areas of high and low rainfall in conformity with the known differences in deposition of this element. (TCO)

15240 BIOLOGICAL DOSIMETRY IN RADIATION INJURY. Alexander H. Woods (Univ. of Oklahoma, Oklahoma City). J. Med. Assoc. Georgia, 52: 512-14(Dec. 1963).

Attempts are made to determine radiation doses in terms of biological parameters, so that in heavily irradiated persons the need for bone marrow transplantation may be precisely evaluated. The potential hazards of promiscuous bone marrow hemografting in random cases of radiation injury are emphasized. These hazards stem from the fact that the same marrow homograft which can be lifesaving after lethal exposure paradoxically increases mortality after low doses of radiation. Systems for measuring the effect of radioprotective chemicals and the action of radiomimetic drugs must provide the following criteria for biological dosimetry: reflect actual tissue injury; measurable soon after the insult; reflect injury to all tissues in known proportions; be precise and repeatable; and require a minimum of special skills and equipment. One such system based on radioiron kinetics is described. (TCO)

15241 IONIZING RADIATION AND CHEMICAL PROTECTION. PART I. Francesco Toffoli. Rass. Chim., [16]: 38-44(Jan.-Feb. 1964). (In Italian)

After some generalities on radiations, ionizing radiations, and natural and artificial radioactivity, some elementary concepts on the increase of the ambient radiation that can be caused by nuclear explosions and on the somatic and genetic consequences for man are reported. (tr-auth)

15242 ANAMNESTICALLY ORIENTED STUDIES OF MOTHERS OF MALFORMED INFANTS AT THE WOMEN'S CLINIC OF ROSTOCK UNIVERSITY FROM 1960 TO 1962. D. Kuehne (Universitat, Rostock, Ger.). Zentr. Gynaekol., 85: 1475-80(Oct. 12, 1963). (In German)

In a study to relate incidence of birth malformations to medical histories of patients, 7 mothers of abnormal children had histories devoid of any treatment but radiation. The husband of one of these had been irradiated in the lumbar spinal region for spondylitis. The child of a woman who had worked as an x-ray technician was born with a pronounced hydrocephalus. During the first weeks of pregnancy she had been exposed to additional irradiation, because during her work she had been required to hold a child who was to be irradiated. The husband of this patient had been irradiated 50 times since the age of 12 for osteomyelitis. Another patient was a nurse assigned to an infant ward, where almost daily she had been required to hold infants who were undergoing x-ray studies. (TCO)

15243 PERMISSIBLE DOSAGE AND RISK FACTORS OF IONIZING RADIATION. Charles F. Behrens. p.340-70 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The biological effects of various doses of radiation are reviewed from the standpoint of permissible dosage and risk factors associated with the diagnostic or therapeutic uses of radiation. Topics discussed include the general effects of ionizing radiation, the effects of radiation on the skin, eyes, hematopoietic system, life span, germ cells, and development. The induction of malignant diseases by radiation and clinical radiation hazards are also discussed. Criteria used in determinations of maximum permissible radiation doses are outlined. The radiation hazards from the use of nuclear weapons are also considered briefly. (68 references.) (C.H.)

Radiotherapy and Radiodiagnosis

Refer also to abstracts 15117, 15704, 15885, 15987, and 16323.

15244 (ORNL-tr-480) RENAL EXPLORATION WITH NEOHYDRIN AND MERCURY BICHLORIDE TAGGED WITH RADIOACTIVE MERCURY Hg^{197} AND Hg^{203}. C. Raynaud, A. Desgrez, and C. Kellershohn. Translated for Oak Ridge

National Lab., Tenn., from Vol. V of Radioactive Isotopes in Clinic and Research, 5th International Symposium, Bad Gastein, Austria, Jan. 9-12, 1962. 39p. Dep.(mn); $3.60 (fs), $1.37(mf) JCL.

Radioactive mercury injected in the form of Neohydrin ^{203}Hg or $^{197}HgCl_2$ is essentially taken up by the renal cortex and is eliminated only very slowly from there. A determination of the renal uptake of mercury by external counting for several days permits an uptake curve for each kidney to be obtained. A series of curves obtained with a normal and a pathological kidney was investigated. The lower uptake of the pathological kidney was evident with both mercury compounds utilized. This uptake determination permits a localization of a unilateral disorder without the need of separate urine samples. It is indicated whenever intravenous pyelography is impossible or inapplicable. No interpretation of this lower uptake is possible as yet, but in order to define the history of the mercury, a kinetic study was conducted with a determination of the total body activity, renal uptake, and plasma, urine, and fecal radioactivity. The renal scans were obtained with Neohydrin ^{203}Hg and $^{197}HgCl_2$ with satisfactory and very comparable results. ^{197}Hg, however, seems extremely interesting in consideration of its short physical half-life and the consequent possibility of a repeated examination. (auth)

15245 THERAPEUTIC PROBLEMS OF DIABETIC ANGIOPATHY. E. Kodejszko and A. Czyzyk (III Medical Clinic, Medical Academy, Warsaw). Abhandl. Deut. Acad. Wiss. Berlin, Kl. Med., 1964: 317-22. (In German)

In two patients with symptoms of late diabetes given 6 μC of ^{90}Y to produce partial hypophysectomy there was evidence of marked reduction of hypophyseal function and of reserves of ACTH. The radioisotope was implanted intracellularly. In both patients who were observed for 4 months after implantation of the ^{90}Y the daily insulin requirement was considerably reduced, but there was no evidence of improvements of skin changes or of kidney function. In one of the patients punctiform subcutaneous hemorrhages recorded after the treatment. The results were not considered as favorable as they might have been if the ^{90}Y had been given earlier in the course of development of the diabetic complications. The use of intracellular implantation of ^{90}Y exposes the patient to much less trauma than does adrenal-ectomy. In addition, the post treatment procedures are simplified and hormone substitution therapy is considerably reduced in patients who have undergone subtotal hypophysectomy as compared to patients subjected to total bilateral adrenal-ectomy. (BBB)

15246 SUPERVOLTAGE RADIOTHERAPY: A REVIEW OF THE PHYSICAL ASPECTS. D. E. A. Jones (Mount Vernon Hospital, Northwood, Middx, Eng.). Acta Unio Intern. Contra Cancrum, 20: 1676-81(1964).

The advantages of supervoltage beam therapy in comparison with treatment at conventional x-ray qualities are reviewed on a physical basis. They are shown to arise mainly from the considerable reduction in the scatter component of the beam, and from the fact that differences in the atomic number of tissue components play a diminishing role with increasing radiation energy. These effects were examined in relation to the size and shape of the body contour and to the presence of bony inclusions and air spaces, from the viewpoint of the accurate estimation of dose. (auth)

15247 THE PLACE OF A 22 Mev BETATRON USED WITH GAMMA BEAM IN THE MANAGEMENT OF TUMORS OF THE PELVIS. G. H. Fletcher (Univ. of Texas, Houston). Acta Unio Intern. Contra Cancrum, 20: 1686-95(1964).

The two main groups of cancer best treated with the 22 Mev beam, uterine cervix, and urinary bladder, were evaluated. A 22 Mev betatron permits the systematic use of high dose whole pelvic irradiation in the treatment of late stages of cancer of the uterine cervix and in the biologically more aggressive tumors associated with pregnancy. A 40% three-year survival rate has been found in Stages B_2 and C. By combining supervoltage irradiation with either total cystectomy or interstitial irradiation, it is hoped that this figure can be improved. A 22 Mev beam allows easy delivery of high doses for miscellaneous types of tumors occurring in the pelvis. In this latter group, specific survival rate cannot be demonstrated because of the great variety of clinical conditions, but it is a more effective way to palliate and some patients have apparently been cured of their disease. (P.C.H.)

15248 PHYSICAL ASPECTS OF SUPERVOLTAGE RADIATION THERAPY. V. A. Petrov (Central Research Inst. of Medical Radiology, Ministry of Public Health, USSR). Acta Unio Intern. Contra Cancrum, 20: 1701-3 (1964).

By the use of bremsstrahlung it is important to increase radiation energy up to 5–10 Mev. It is of great importance in electron therapy to choose the optimal value of energy for each target depth. Dose-rate at the level of irradiation of the seat of tumor must be of the order of 150–200 Rad/min. In electron therapy the mean dose-rate value mainly depends on the current value. (auth)

15249 BIOPHYSICAL ASPECTS OF THE USE OF HIGH ENERGY ELECTRONS. J. S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). Acta Unio Intern. Contra Cancrum, 20: 1704-6(1964).

Calorimetric and radiation chemical experiments are described in the dosimetry of high energy electrons. A demonstration of the polarization phenomenon is also described as well as measurements of its magnitude. Depth and isodose distributions produced by high energy electrons are issued including their dependence on field size collimator material, scattering medium, and energy. Experiments on biological action have revealed no qualitative difference between electrons and x rays. An illustration is given of the treatment planning methods that are employed to exploit the advantages of high energy electrons in therapy. (P.C.H.)

15250 HIGH-ENERGY MOVING FIELD ELECTRON BEAM FOR CANCER THERAPY. L. H. Lanzl (Argonne Cancer Research Hospital, Chicago). Acta Unio Intern. Contra Cancrum, 20: 1707-14(1964).

The beam-scanning device and linear accelerator of the Argonne Cancer Research Hospital provide a unique facility for cancer therapy with electrons. The linear accelerator is capable of delivering electrons of any desire energy between 5 and 50 Mev. The scanning device directs the electron beam, which is approximately ½ cm in diameter, over the tumor area. The beam is guided by means of magnetic fields, and can scan arbitrary field sizes and shapes up to 20 × 20 cm under one treatment modality. It can also carry out convergent-beam therapy over an arc up to 360°, with a field width up to 20 cm. Extensive measurements of relative dose distributions were made in a heterogeneous phantom under a wide assortment of treatment conditions. Use of heterogeneous phantoms resulted in extensive modification of the dose distributions formerly obtained by homogeneous phantoms, particularly in regions containing bone, lungs, and air passage. (auth)

15251 HIGH ENERGY ELECTRON BEAMS IN THE TREATMENT OF HEAD AND NECK CANCERS. Fl. C. H. Chu, H. Perry, J. S. Laughlin, J. J. Nickson (Memorial and James Ewing Hospitals, New York and Sloan-Kettering Inst., New York). Acta Unio Intern. Contra Cancrum, 20: 1720-4(1964).

High energy electrons generated by the betatron of Memorial Sloan-Kettering Cancer Center, New York City, have been used for treatment of patients since 1955. The physical characteristics of electron beams make them especially applicable to the treatment of superficial and moderately superficial lesions such as tumors occurring in the head and neck regions. From June 29, 1955 to December 31, 1960, more than 300 patients with tumors of the head and neck regions were treated with electrons. Most of them had advanced epidermoid carcinoma with metastases to the neck nodes. The techniques of treatment are described with particular emphasis on the use of the physical properties pertaining to the electron beams, normal tissue reactions, as well as the tumor response. (auth)

15252 RADIOTHERAPY WITH LIQUID RADIOISOTOPES. D. E. Kahlson, W. B. Nalley, and A. Raventos (Lockheed Nuclear Products, Atlanta). Acta Unio Intern. Contra Cancrum, 20: 1725-7(1964).

Adapting some progress of the technology of nuclear industry to the needs of radiotherapy applicators for interstitial intracavitary and surface uses were planned. By altering the shape of the applicator and varying the fluid radioisotope it contains, a great variety of isodose distribution can be obtained. Some applicators and their clinical use are described. (auth)

15253 THE DIRECT DIAGNOSIS OF MYOCARDIAL INFARCTION BY PHOTOSCANNING AFTER ADMINISTRATION OF CESIUM-131. Edward A. Carr, Jr., Geoffrey Gleason, James Shaw, and Brian Krontz (Univ. of Michigan, Ann Arbor). Am. Heart J., 68: 627-36(Nov. 1964).

A technique was developed for using ^{131}Cs to demonstrate the presence of myocardial infarcts in dogs and in man. Preparation and purification of the isotope are described in detail. Cesium-131 was injected intravenously in doses of 40 to 650 μC in dogs. On the basis of the results obtained in dogs, 13 patients received 1.1 to 2.5 mC intravenously; in the majority the dose was 1.25 mC. The estimated radiation dose (whole body) was 400 mrad. After injection the patient was scanned in the supine position. Myocardial infarcts appeared as cold areas of decreased uptake. In six patients with unequivocal fresh myocardial infarcts, the scans were positive in five and doubtful in one. In two patients who probably had suffered recent myocardial infractions, the scan was positive in one and negative in one. In two patients who had heart disease but who had probably not had recent myocardial infarctions, the scan was negative in one and doubtful in one. The scan was negative in each of three patients with normal hearts. (BBB)

15254 RADIATION RESPONSE AND ITS SIGNIFICANCE IN PATIENTS WITH CANCER OF THE CERVIX. Lauri Rauramo and Seppo Kangar (Univ. of Turku, Finland). Ann. Chir. Gynaecol. Fenniae, 53: 120-30(1964).

Radiation response (RR), observed in the vaginal smear during radiotherapy, was evaluated as a prognostic index. The RR was considered a good response when 75% of the nonmalignant epithelial cells exhibited radiation changes and a poor response when less than 60% of them were so changed. The correlation between RR and the prognosis of 162 patients with cervical carcinoma treated by radiotherapy is reported. An epithelial cell was considered as changed by radiation if it showed size increase, multinucleation, or vacuolation of the cytoplasm. According to their RR, the patients were classified into three groups: group I 0–49%, group II 50–70%, and group III 71–100%. During the observation time (2.5 to 6 yr) 21% of the patients died in group I, 31% in group II, and 14% in group III. Of these patients whose basal cell index was 50 or higher, only 11% died during the time of observation, while the corresponding figure for the others was 26%. The basal cell count and the RR showed a positive correlation. In women of more than 45 yr of age a good RR was found more frequently than in younger ones. It is suggested that a poor RR is a sign of greater hormonal activity in the patient. These results indicate that the best prognosis will be found in patients with a good RR, but the patients with poor RR will not have the poorest prognosis. Apparently the basal cell index is almost as good a prognostic criterion as the RR. If the basal cell index is high, the prognosis of the patient is better than normal. (BBB)

15255 RADIOISOTOPIC DIAGNOSIS OF BRAIN TUMORS. M. Brenner, T. A. Pihkanen, and A. Voutilainen (Univ. of Helsinki and Second Dept. of Hesperia Hospital, Helsinki). Ann. Med. Exptl. Biol. Fenniae (Helsinki), 42: 145-51(1964).

Human serum albumin labeled with radioactive iodine and neohydrine labeled with radioactive mercury were used for the localization of brain tumors in 127 patients. Of 36 intracranial tumors that were histologically verified, 33 (92%) were diagnosed and localized by scanning. The unverified brain tumors established by clinical and x-ray examination alone were localized by scanning in 63%, and the brain metastases in 57%. It was found on comparison of ^{131}I serum albumin and ^{203}Hg neohydrin that smaller intracranial tumors and metastases may be better demonstrated by the latter. The radioactive isotope was in this material best retained by astrocytomas. The scanning examination proved useful also in follow-up checks after radiotherapy. It can also be recommended as an ambulatory method of examination for patients in poor condition. It is a painless and fairly risk-free procedure. The uptake of mercury-203 in kidneys was calculated in 4 cases. (auth)

15256 THE USE OF A GAMMA-ENCEPHALOGRAPHIC TECHNIQUE WITH TWO SEPARATE COUNTERS. A. Chevallier and G. Methlin (Faculte de Medecine, Strasbourg). Ann. Radiol., 7: R797-802(1964). (In French)

A study was made of the results likely to be obtained by a technique of gamma encephalography using two scintillators revolving in parallel planes tangential to the cranial wall, measurements being made after injection of serum albumin labeled with ^{131}I. A simple radiographic method for objective marking of the counting zones is described, which ensures adequate reproducibility during examination. A phantom was used to demonstrate the limits of interpretation in the case of a simulated tumor placed in various geometric positions. The influence of selection as it affects the impulses recorded by the scintillators, is discussed. (auth)

15257 USE OF A NEW ANTIEMETIC IN GYNECOLOGICAL RADIATION THERAPY. E. Picha (Universitats-Frauenklinik, Vienna). Appl. Therap., 6: 43-7(Jan. 1964).

Successful use of a new drug is reported in the treatment of 228 women for gynecologic cancer. The compound used is trimethobenzamide (Tigan), which belongs to the group of acylated amino-alkoxy-benzylamines. Its chemical name is 4-(2-dimethylaminoethoxy)-N-(3,4,5-trimethoxybenzoyl)-benzylamine hydrochloride. The drug's primary site of action is believed to be the so-called chemoreceptor trigger zone (CTZ) in the floor of the 4th ventricle. The CTZ plays a considerable role in emesis caused by radiation therapy or by infections accompanied by uremia and acetonemia. Because it acts exclusively on the CTZ, Titan has advantages over drugs acting directly on the emesis center, for direct stimulation of the emesis center is usually associated with sedative side effects, such as fatigue, depression, sleepiness, and other central-depressive reactions. Both animal and clinical trials have demonstrated its nontoxicity. It is well tolerated and free from marked sedative effects. The incidence of serious side-effects does not exceed 2 or 3%, which is low when compared with other effective antiemetics. Out of a total of 228 women, 215 were freed of emesis; only 13 did not respond. (TCO)

15258 ON ROENTGEN PRE-IRRADIATION. E. Frey (Universitat, Bern). Belg. Tijdschr. Geneesk., 19: 945-71 (Sept. 15, 1963). (In Dutch)

Theoretical considerations and the discussion of experimental results with tumors indicate that the principle of preirradiation is the most efficacious mode of therapy in combined tumor treatment. Advantages of the method include decrease in local recurrence, decrease or prophylaxis of propagation, and the conversion of inoperable tumors into operable ones. Disadvantages include occasional disturbances of healing of the wound; this is not important in relation to the improvement of biological results. Preirradiation may use a small dose, short interval, and mandatory postirradiation; or it may use large dose, long interval, and limited postirradiation. The first method applies to operable tumors, the second, to inoperable and those on the borderline. High-voltage therapy, particularly with fast electrons, is superior to the conventional depth therapy and is recommended whenever possible, although the latter technique has definite uses. Roentgen preirradiation is particularly efficient in cases of mammary carcinoma, carcinoma of the upper jaw, and other malignomas. Systematic use of the technique is considered as the best route to efficiency improvement with other malignomas. Cytostatic preliminary treatment alone as a substitute for preirradiation is not recommended. (BBB)

15259 GRANULOCYTE RESERVE FOLLOWING RADIATION THERAPY AS STUDIED BY THE RESPONSE TO A BACTERIAL ENDOTOXIN. Samuel Heilman and Martin E. Fink (Yale Univ., New Haven and Grace-New Haven Community Hospital, New Haven). Blood, 25: 310-24(Mar. 1965).

The granulocyte response to an intraveneous injection of Pyrexal, a highly purified bacterial endotoxin, was used as an assay of the marrow granulocyte reserve in patients who had received radiation therapy for various types of neoplasms. The response to the endotoxin was correlated with the amount of marrow irradiated. Only those patients with large volumes of marrow irradiated had abnormal responses to Pyrexal. No patient receiving radiation therapy to the head and neck, or thorax, or pelvis alone, regardless of dose, developed an abnormal response to Pyrexal. Early changes in the marrow granulocyte reserve were also studied in patients before, during, and after radiation therapy. (auth)

15260 HIGH ENERGY ELECTRON TREATMENT PLANNING FOR INHOMOGENEITIES. John S. Laughlin (Memorial Hospital and Slaon-Kettering Inst., New York). Brit. J. Radiol., 38: 143-7(Feb. 1965).

A system in use for the modification of unit density isodose distributions in high-energy electron irradiation is briefly described. Since the absorption of electrons is determined by quite different processes from those applicable to x rays this system was based on the specific characteristics of electron absorption. Correction in the system starts with the representation of an isodose distribution by several depth dose distributions along axes emanating from a virtual source. Segments of these unit density depth dose distributions are translated sequentially by amounts dependent on the location, extent, and electron density of the inhomogeneous region. The various steps in this system are briefly presented and lead to the corrected dose in and beyond a region of lower density, such as lung, and correct for the effects of both attenuation and scatter. In the case of limited regions of higher density and higher atomic number, such as bone, the method provides for the systematic correction of the dose beyond the inhomogeneity. The enhancement of dose in bone with electrons is rarely large enough to be clinically significant and is separately computed on the basis of experimental measurements made with different amounts of bone equivalent material. The differences between the corrected actual distribution of dose in the patient and that indicated by uncorrected unit density distributions are so significant that such corrections would appear to be essential if the physical advantages of high energy radiation therapy are to be realized in practice. (P.C.H.)

15261 TISSUE-PHANTOM RATIOS—AN AID TO TREATMENT PLANNING. C. J. Karzmark, Angela Deubert, and R. Loevinger (Stanford Univ., Calif.). Brit. J. Radiol., 38: 158-9(Feb. 1965).

In treatment planning for moving field therapy using x and γ rays, it is suggested that air measurements be replaced by a calibration procedure, common to all energies and all types of radiation, which places emphasis on absorbed dose measurements in a phantom. In this context it would be appropriate to replace the tissue-air ratio (TAR) by a new ratio which may be called the tissue-phantom ratio, TPR. In close analogy with the TAR, the TPR is defined as the ratio of two doses under conditions of electronic equilibrium: TPR = (D_t/D_p). Application of the method on phantom is illustrated. (P.C.H.)

15262 DOSES OF X-RAYS DELIVERED TO THE MOTHER AND FETUS BY RADIO-OBSTETRICAL EXAMINATIONS. C. M. Gros, F. Weill, and P. Burgy (Service Central de Radiologie, Strasbourg). Bull. Federation Soc. Gynecol. Obstet. Langue Franc., 12: 617-24(Nov.-Dec. 1960). (In French)

To estimate the risk attached to radio-obstetrical examinations the following measurements were required: average fetal dose, average dose to the maternal gonads, and average dose to the fetal gonads. Measurements were made on nine pregnant women at two skin levels (the central points of the entering and emerging ray) and the posterior vagina. The doses to the fetal skin and fetal gonad level were calculated by reference to the established curve of absorption for the x rays utilized. Irradiation with 130-kv x rays delivered from the back gave the following average doses: skin: 2.50 R; ovaries: 0.100 R; fetus: 0.250 R; fetal gonads: 0.400 R. Passed through a 0.3 mm aluminum filter the doses were: skin: 0.45 R; ovaries: 0.110 R; fetus: 0.050 R; fetal gonads: 0.100 R. The complete placentography doses are, respectively: 2.95 R, 0.220 R, 0.300 R, and 0.500 R. Irradiation vertically through the abdomen gave the following average doses: skin: 2.10 R; ovaries: 0.100 R; fetus: 0.200 R; fetal gonads: 0.600 R. From a posterior-lateral position the doses were: skin: 7.0 R; ovaries: 0.280 R; fetus and fetal gonads: negligible. In the position of Rosa (patient on back with legs bent) the doses were: skin: 2.0 R; ovaries: 0.100 R; fetus and fetal gonads: negligible. The complete pelvimeter doses were, respectively: 11.10 R, 0.480 R, 0.200 R, and 0.600 R. Thus, radio-obstetrical examinations represent only about 10% of the radiation dosage an organism would receive in 30 years by natural irradiation. Statistically the danger to the individual and the population from radio-obstetrical examinations is minimal. (BBB)

15263 LATE RESULTS OF HOMOTRANSPLANTATION OF THE LUNG IN DOGS. David A. Blumenstock, John A. Collins, Herbert B. Hechtman, David J. Hosbein, E. Donnall Thomas, and Joseph W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Diseases Chest, 45: 484-7(May 1964).

Homotransplantation of the lung was performed in 37 dogs treated with antimetabolites, radiation, or donor antigen in an attempt to block the immunologic responses in the recipient. Eight animals received methotrexate (0.1 to 0.05 mg/kg) subcutaneously three times a week throughout the post-transplant period. Twelve animals received azathioprine (5 to 10 mg/kg daily) by mouth. Eleven animals received 1200 to 1770 R whole-body irradiation followed by simultaneous homotransplantation of bone marrow and lung. Six animals received pretransplantation exposure to prospective donor blood while attempts were made to depress immunologic response by subiethal radiation or chemotherapy. Two of the eight animals treated with methotrexate after transplantation survived beyond three months. Of the 12 animals receiving azathioprine after transplantation, only one survived beyond three months. A single animal from the group of 11 receiving radiation with lung and marrow homotransplantation survived beyond three months. Five of the six animals pretreated with donor antigen survived longer than three months. Although four of 37 animals subjected to left lung homotransplantation are alive and in apparent good health 15 to 29 months after transplantation, pulmonary function studies have demonstrated progressive loss of function in the transplanted lung. It was concluded that antimetabolite drugs and radiation depressed the immune mechanisms in the host animal and prolonged survival far beyond nontreated animals, but were not sufficient to prevent, ultimately, complete loss of pulmonary function. (BBB)

15264 STUDIES ON THE FREQUENCY AND SEVERITY OF THROMBOEMBOLIC COMPLICATIONS IN GYNECOLOGIC AND OBSTETRIC PATIENTS. D. Hofmann (Universitat, Giessen, Ger.). Geburtsh. Frauenheilk., 24: 889-902 (Oct. 1964). (In German)

The incidence of thromboembolic complications as a result of radiotherapy and other treatments is considered. Statistical investigations in a large number of gynecologic and obstetric patients are reported with special reference to their relation to the type of treatment, the age of the patient, and pre-existence of varicose veins. The incidence of thrombosis and embolism was highest in the group of patients operated upon for carcinoma. A much lesser incidence was found in the group of patients undergoing vaginal surgery, undergoing laparotomy, and those admitted for obstetric reasons. The lowest incidence of thrombosis and embolism occurred in patients admitted for dilatation and curettage and patients irradiated for carcinoma. Obstetric patients more often developed thrombophlebitis, and patients

who had operations for carcinoma more often developed embolism, some of them fatal embolisms. The onset of clinical signs of thrombosis or embolism has its highest incidence in obstetric patients on the second postpartum day. In surgical patients complications became evident up to three weeks postoperatively. In all groups of patients the incidence of thrombosis and embolism increased with rising age. The predisposing influence of pre-existing varicose veins was seen; however, patients with varicosities did not necessarily run a higher risk of developing embolism. (BBB)

15265 DOUBLE CARCINOMA OF THE UTERUS: CONTRIBUTION TO THE PROBLEM OF MULTIPLICITY OF PRIMARY CARCINOMA AND THE QUESTION OF RADIATION-INDUCED CORPUS CARCINOMA. H. Jopp and H. A. Krone (Universitat, Munich). Geburtsh. Frauenheilk., 24: 1067-78(Dec. 1964). (In German)

The pertinent literature is reviewed with citation of 63 references. Five new cases are presented in which two carcinomas developed in the uterus, apparently as independent tumors and not representing recurrence of or metastasis from a primary tumor. Since all of these patients received radiotherapy for the tumor first diagnosed, the possibility of the second tumor arising from irradiation is considered. A general survey on primary multiplicity of cancers is presented, and criteria for the diagnosis of true double carcinomata are defined. (TCO)

15266 EFFECT OF RADIOTHYROIDECTOMY IN CHICKS WITH EMPHASIS ON GLYCOGEN BODY AND LIVER. J. G. Snedecor and D. B. King (Univ. of Massachusetts, Amherst). Gen. Comp. Endocrinol., 4: 144-54 (Apr. 1964).

Radiothyroidectomy was induced in 5- to 9-day-old White Rock chicks by injection of 1.5 mC ^{131}I per 100 g body weight. Surveys for residual radioactivity and for ability to trap ^{131}I following a test dose indicated that the birds were uniformly and completely thyroidectomized by the initial ^{131}I treatment. In no case did the survey meter indicate any thyroid radioactivity significantly above background for any of the birds that received the initial dose of ^{131}I at least 8 days before a ^{131}I uptake test. Most of the ^{131}I must have been excreted by that time, and no detectable amount was present in thyroid tissue. Of the birds which were tested for ability to trap iodine by administration of a small (16 μC) dose of ^{131}I, the controls showed activities of 1600 to 4000 cpm above background, while none of the treated birds showed a count significantly above background (200 cpm). Birds autopsied from 8 to 43 days later were considered severely hypothyroid by several other criteria. Glycogen-body weight was reduced in one experiment but not in another. Glycogen concentration in the glycogen body was not affected. Liver weights of radiothyroidectomized birds were the same as the control, but on a per-cent body weight basis the livers were significantly enlarged. Values for liver glycogen in the radiothyroidectomized birds were high and remained high in chicks fasted 18 hr. Radiothyroidectomy had little effect on blood glucose or muscle glycogen. Weights of testes, combs, and spleens were decreased in the hypothyroid birds, whereas the adrenal weights were similar to the controls despite the marked body weight differences. (BBB)

15267 IRRADIATION INFLAMMATION IN DERMATOLOGICAL PRACTICE. W. Schneider (Universitats-Hautklinik, Tubingen, Ger.). Hautarzt, 14: 484-9(Nov. 1963). (In German)

The amount of inflammation produced by irradiation is, in general, directly proportional to the amount of radiation received. However, it is usually difficult to detect differences between effects of the usual depth therapy, Chaoul irradiation, or soft radiation. In other words, soft radiation produces the same therapeutic effects as the others, and has the additional advantage that the skin is protected more. When soft radiation is used the tissue half value depth must be chosen so that the depth to which the tissue is irradiated is adequate for the treatment desired, and the size of the field is great enough to include the surrounding connective tissue. Although the amount of radiation administered per dose is reduced and produces correspondingly a smaller therapeutic effect, it has the advantage that it can be administered more frequently, or fractionated. As a result the total dose administered often can be reduced, but the total irradiation time may not be chartered. In dermatological practice the usual Be equipment used to produce soft radiation is generally adequate for the irradiation treatment problems customarily encountered using lower doses of soft radiation. With the increased skin protection that it affords it is possible to control the space dose very efficiently to obtain therapeutic effects previously obtained only with higher doses of harder radiation. (BBB)

15268 RADIOACTIVE COLLOIDAL GOLD IN THE TREATMENT OF MALIGNANT PLEURAL EFFUSION. J. R. Shah and M. S. Warawdekar (G. T. Hospital, Bombay). J. Assoc. Physicians India, 12: 63-7(Jan. 1964).

The use of radiogold in colloidal form injected into the pleural cavity is convenient and offers a new approach in the management of malignant effusions. Therapeutic administration of radiogold is a simple and safe procedure. There are no side effects, though occasionally mild radiation sickness may cause nausea and anorexia, and in a few patients bone marrow depression produces leucopenia. The clinical course of pleural mesothelioma was followed for 24 months after treatment with ^{198}Au. The ^{198}Au was prepared from ^{197}Au by neutron bombardment. In the process of radioactive decay, β rays with an energy of 0.96 Mev and γ rays with energies of 0.12 and 0.41 Mev are emitted. The resultant product of decay is a stable ^{197}Au. The half-life period of ^{198}Au is 2.7 days. In colloidal preparations of radiogold the particle size varies from 0.003 to 0.007 μ, and because of its colloidal nature, radiogold is prevented from rapid absorption into the circulation and is distributed over the pleural surface. Irradiation of the pleura is largely determined by β rays which penetrate only 2 or 3 mm into the tissues. It is thus possible to deliver a large dose of localized radiation to the pleural surface without involving the overlying or underlying tissues of the thorax. The γ-ray emission produces only a small fraction of pleural irradiation, but serves the useful purpose of enabling the assessment of radioisotope distribution, by Geiger counter. The actual amount of heavy metal involved is pharmacologically an insignificant dose. In the treatment of malignant pleural infusion, ^{198}Au in a total dose of 250 mC was administered intrapleurally in divided doses. A dose of 80 to 90 mC diluted in normal saline was instilled after aspirating all the pleural fluid at intervals of 10 days. The fluid reaccumulated immediately following the administration of radiogold, but on completion of therapy, the general condition of the patient improved. Fluid did not accumulate and the patient was apparently free from breathlessness for longer periods. No radiation sickness, bone marrow depression, or other side-effect was observed after administration of the total dose of 250 mC of ^{198}Au. (BBB)

15269 USE OF A THYROID SUPPRESSION TEST AS A GUIDE TO PROGNOSIS OF HYPERTHYROIDISM TREATED WITH ANTITHYROID DRUGS. Carl E. Cassidy (New England Center Hospital, Boston and Tufts Univ., Boston). J. Clin. Endocrinol. and Metab., 25: 155-6(Feb. 1965).

Fifty-three thyroid suppression tests were carried out at the end of a year of treatment of hyperthyroidism with antithyroid drugs. Two to 7 years later (average 47 months), 27 patients were well and 26 patients had relapsed or had experienced a recurrence within periods ranging from a few days to 69 months (average 7 months) after antithyroid drugs were discontinued. The average value of 24-hr ^{131}I uptake after the test for those who remained well was 23%, in contrast to 58% for those in whom hyperthyroidism recurred ($p < 0.001$). The test indicates the likelihood of a prompt relapse of hyperthyroidism after treatment is discontinued if the value is 50% or more and a prolonged or permanent remission when it is 30% or less. (auth)

15270 SYMPOSIUM ON SOME USES OF IONIZING RADIATION IN PREGNANCY. II. THE RADIOTHERAPEU-

TIC ASPECT. A. G. S. Cooper (Queensland Radium Inst., Brisbane, Australia). J. Coll. Radiologists Australasia, 8: 128-30(June 1964).

Sequelae likely to arise from irradiation during pregnancy are discussed. The fetus is subject to somatic injury, the common malformations being microcephaly, anencephaly, and blindness. Some delayed sequelae may be serious, such as mental deficiency or idiocy, and even if the infant appears normal, gene mutations may be carried into adult life. To produce sterilization in the human female a single exposure of ~500 Rad to the ovaries or a biologically equivalent fractionated exposure is required. An example of a therapeutic abortion induced in an irradiated patient is presented. In considering radiotherapy in malignant conditions affecting the pregnant woman, the possible benefits of palliative radiation should be weighed against the chance of fetal damage. If, however, radiotherapy alone, or in combination with surgery, provides a curative prospect, it should not be withheld provided direct irradiation of the fetus can be avoided. When radiotherapy is necessary during pregnancy, it is desirable to avoid the period from the second to the sixth week when the embryo is particularly vulnerable but, in practice, a pregnancy is very rarely diagnosed during this early phase of gestation. Treatment of breast cancer in pregnancy is discussed. Owing to the lower amount of scattered radiation with supervoltage radiotherapy, it is desirable to use this modality if available, as well as extra lead protection for the lowermost field margin. Under these conditions, actual measurement of the dose at the umbilical level showed 0.6% of the incident skin dose with the usual fields used. This amounts to less than 30 Rad on the skin of the lower abdomen, and a smaller amount of radiation would reach the pregnant uterus. Treatment plans for cancers in other regions of pregnant patients are also outlined. (TCO)

15271 THE USE OF CROSSED GRIDS IN RADIOGRAPHY. G. J. Pauline (Dept. of Diagnostic Radiology, Sydney). J. Coll. Radiologists Australasia, 8: 298-301(Oct. 1964).

The function and purpose of grids in radiography is discussed. A grid of criss-cross that allows more freedom in focus-film distance is described. The grid is more efficient that a linear grid of more than twice its ratio. The crossed grid may be considered as two linear grids placed one on top of the other with their lead strips at right angles to each other. Thus the failure of the linear grid in that it stops only the scattered radiation running across the line of the strips is avoided. The superiority of the crossed grid is mainly evident at voltages under 100 kvp. (P.C.H.)

15272 THE OBTAINING OF ISODOSES IN ROTATORY ROENTGENTHERAPY WITH MULTIPLE BUNDLES. Jean-Marc Legare (Universite, Montreal). J. Radiol., Electrol. Med. Nucl., 45: 649-61(Nov. 1964). (In French)

A method for the preliminary obtainment of isodoses issued from numerous bundles is described. The former are applied to the tumor when the same is located at a depth exceeding 6-8 cm, according to the field size, under the condition that the focus-rotation center distance (FRD) remains constant. In order to calculate the exact isodoses at the first centimeters of tissue, the isodoses of the infinite phantom are multiplied by the convenient correctives. As an instance, the method is applied to the situation with 4 convergent bundles at a crosspoint and a comparison is then made between these isodoses and those of the common method. In cyclotherapy, the use of such isodoses of infinite phantom and of the correctives allows actual isodoses to be obtained wherever the rotation center is located on the patient's section. When the rotation center is at a distance from the skin that exceeds 6-8 cm, the method for the calculations in depth is the same as the one commonly used in rotatory telecobaltherapy, while the correctives are equal to the unit. An explanation is given for obtaining isodoses for the infinite phantom of a 6.5 × 6.5 cm field at the rotation center located at 65 cm from the focus with a 2 mm copper HAL (half-attenuation layer), reckoning from a 5 × 5 cm bundle at a FSD of 50 cm. All the correctives of the first centimeters of tissue exposed to bundles between 4 × 4 and 20 × 20 cm at the rotation center with a FCD of 65 cm and a 2 mm copper HAL were calculated. (auth)

15273 INDICATIONS OF THE ACCELERATED ELECTRONS THERAPY. P. M. van Vaerenbergh and K. Schelstraete (Universite, Ghent). J. Radiol., Electrol. Med. Nucl., 45: 681-90(Nov. 1964). (In French)

After five years experience, it was concluded that betatron (accelerated electrons) therapy constitutes a great progress in the roentgentherapic technique. The energy of the apparatus used is able to reach 6 cm with 80% of the superficial dose, this therapy is used for all the superficial tumors that may be reached if they are tissularly homogeneous (of nearly equal density). Betatrontherapy is the only technique that for infiltrating superficial tumors is able to distribute the greater integral dose-volume limited to the tumor, without damaging the environmental tissues and in the absence of the systemic disorders noted with the conventional irradiation. Experience concerning 500 cases was compared with that of others, so as to contribute to the elaboration of methods appropriated to some varieties of tumors, methods that shall be based on the mean world experience. (auth)

15274 CYTOLOGICAL STUDIES ON THE INFLUENCE OF ESTROGEN TO THE RADIOSENSITIVITY OF CERVICAL CANCER. Kohachiro Koga, Mamoru Yamada, and Hisao Tanaka (Kyushu Univ., Fukuoka). Kyushu J. Med. Sci., 14: 379-83(Dec. 1963).

An evaluation was made of estrogen as a sensitizer. Estrogen injections were made in patients with cervical cancer during radiotherapy and the changes of radiosensitivity observed cytologically on their vaginal smears. Of 72 patients with invasive cancer, 43 were injected with estrogen and 29 were treated as a control group. All patients were treated radiologically. In the estrogen-treated group, 1 to 4 mg of estradiol monobenzoate was injected every day or every other day beginning at the time of radiotherapy. Concurrently, 10 to 20 mg of estradiol valerianate was given every 10 days. The total dose of the two estrogens was 60 to 120 mg. Daily vaginal smears were taken during the course of treatment, and were examined for SR (sensitization response), RR (radiation response), and decrease of cancer cells. Histologic changes and changes in lactic dehydrogenase (LDH) were also observed. After three days estrogen administration, it did not appear to be effective in raising the SR of patients with cervical cancer. However, the cornification index showed high levels 5 or 6 days after beginning of estrogen injection, indicating that the effect of estrogen appears in this time. Some influence of estrogen administration was seen by the comparison of SR and RR. In the control group of 18 cases with poor SR, 15 cases or 83.3% had poor RR, but in the estrogen group of 32 cases with poor SR, only 13 cases or 40.6% showed poor RR and 19 cases or 59.4% showed good RR. The decrease of tumor cells and the macroscopic changes of tumor showed good agreement with RR. Radiosensitivity is generally greater in immature cancer cells and estrogen apparently has the function of restraining the maturation of cancer cells and also functions as an accelerator of cancer growth. The level of LDH activity rises with development of cancer and decreases with its cure. LDH rose rapidly after estrogen administration, indicating that estrogen stimulates the growth of cancer. On the other hand, estrogen stimulates proliferation of the endometrium and dilatation of the capillary vessels. Thus, the injected estrogen stimulated local circulations and oxygen tension, and secondarily the sensitivity to radiation. (BBB)

15275 STUDIES ON THE EFFECT OF ESTROGEN ON THE RADIOSENSITIVITY OF CERVICAL CANCER, WITH SPECIAL REFERENCE TO THE PATTERNS OF SERUM LACTIC DEHYDROGENASE AND BETA-GLUCURONIDASE. Yoji Takiguchi (Kyushu Univ., Fukuoka). Kyushu J. Med. Sci., 14: 403-19(Dec. 1963).

Alterations of serum lactic dehydrogenase (LDH) and β-glucuronidase activities were followed in 62 patients with cervical cancer who were treated with radiation, and in some administrated estrogen combined with radiation. At-

tempts were made to estimate the influence of estrogen on the radiosensitivity of cervical cancer and to use the alterations of serum enzyme activities to evaluate the radiosensitivity of cervical cancer. Administration of estrogen was started three days before the beginning of radiation treatment and continued for about one month. Patients were given a series of five courses of ^{60}Co or x irradiation therapy, each consisting of 400 R. Both serum enzyme activities in the patients with cervical cancer showed increases compared with normal controls and patients with non-malignant diseases. Serum LDH and β-glucuronidase activities in the patients with cervical cancer showed a tendency to decrease after operative removal of tumor and postoperative radiation therapy. The alterations of serial serum LDH and β-glucuronidase activities in the patients with cervical cancer, who were treated with radiation, showed four patterns: a rise from initial levels and prompt return to lower levels; gradual return to lower levels; no change in initial levels; or rise from initial levels to higher levels. Serial measurement of these serum enzyme activities in the patients with cervical cancer, who were treated with radiation reflected the radiosensitivity of cervical cancer and clinical changes. Administration of estrogen during radiation appeared to somewhat elevate the radiosensitivity of cervical cancer. The first two enzyme patterns were considered to be the most favorable and occurred most often when the Graham radiation response (RR) cytologic tests offered a good prognosis. Conversely, the latter two enzyme patterns were noted most frequently in patients with a poor RR test. (TCO)

15276 A RADIOISOTOPE DILUTION TECHNIQUE FOR THE QUANTITATIVE STUDY OF CORONARY ARTERY DISEASE POSTMORTEM. N. Alexander Davis (Alfred Hospital, Melbourne). Lab. Invest., 12: 1198-203(Dec. 1963).

A new technique using a radioisotope (^{131}I) for quantitative examination of the volume of the coronary arteries of human hearts studied post-mortem is described. The technique is applicable to the study of arteries with calcified walls and narrow and tortuous lumina and quantitates the alterations in vessel capacity produced by diseases affecting the arteries both focally and diffusely. The injection medium consisted of an aqueous solution of latex in which had been suspended fine crystalline barium sulfate. Immediately before each experiment, 25 μC of ^{131}I in the form of radioiodinated serum albumin was added to 25 ml of the latex medium. The injection was made into both coronary arteries simultaneously at a pressure equal to the systolic blood pressure that had obtained during life. From radiograph a tracing was prepared and used for charting the findings of the macroscopic examination. The radioactivity of the artery was measured by counting the number of γ-ray emissions using a well-type scintillation detector. Using the radioactivity data collected in this manner the capacity of the coronary artery samples was calculated using the following formula: $(C_a \times 1000)/C_f$ = volume of the lumen in mm^3/cm of length; where C_a is the number of emissions counted, minus background, per unit time, per cm of length of the artery; and C_f is the count per unit time of 1 ml of the injection medium. The findings in three hearts, one normal and two diseased, are presented to indicate the validity and potential value of the technique. (TCO)

15277 THE IMPORTANCE AND AIMS OF NUCLEAR MEDICINE IN THE HOSPITAL. H. Oeser (Universitat, Berlin). Magy. Radiol., 15: 129-38(June 1963). (In Hungarian)

A review of developments in radiology from discovery of x rays to the present is given and modern applications of radiation in medicine are listed. It is suggested that a separate science of nuclear medicine be established which would apply to both diagnosis and research employing ionizing radiations. Hospital procedures in diagnostic and therapeutic radiology are outlined. (BBB)

15278 NORMAL CHILD BORN AFTER X IRRADIATION OF THE FATHER SUFFERING FROM SEMINOMA. Janos Kiszel and Jozsef Varga (Orvostudomanyi Egyetem, I. sz Noi Klinika, Budapest). Magy. Radiol., 16: 293-6(Oct. 1964). (In Hungarian)

The case described is that of a father, age 36, and his wife, also 36 yr old, who after 10 yr of marriage had no children. In 1957 the man's left testis was removed because of seminoma which had also spread to the ductus deferens. Because of this he received x irradiation over the four customary areas through the course of 3 months, each area receiving 2000 R x irradiation or a total of 8000 R. Since then he had no recurrence of any symptoms. Sperm tests conducted 2 yr after the operation showed a hypospermic tendency with a considerable number of abnormal forms. One yr later an oligospermic picture with seemingly normal spermatozoa was found. In 1962 the wife entered the clinic complaining of infertility and menorrhea. Examination showed a slight leukorrhea which was treated locally, and she conceived within a month. After a normal full-term pregnancy a 3300-g boy was born, free from any malformations, who now at 18 months of age is normal and healthy in every respect. Subsequent blood tests to verify his paternity were conducted and all three members of the family were found to be type O Rh positive. This is of interest, because up to now data on irradiation-caused genetic damage is scarce and little is known of the regenerating capacity of human germinal tissue. It is not known now whether any abnormalities will develop in this child, or in any subsequent generations, but the relatively long time (6 yr) which elapsed between the irradiation and conception might have been sufficient to eliminate any damaged genes. (BBB)

15279 BRONCHOGENIC CARCINOMA: A COMPARATIVE STUDY OF ORTHOVOLTAGE AND COBALT-60 TELETHERAPY. U. V. Wilcox (Sibley Memorial Hospital, Washington, D. C.). Med. Ann. District Columbia, 33: 61-3 (Feb. 1964).

The effectiveness and complications resulting from the use of x rays and ^{60}Co γ rays for the treatment of lung cancer are compared with reference to 162 patients. These results of irradiation therapy of bronchogenic carcinoma encompass a period of 22 yr, all except the last 2½ yr with orthovoltage x rays, the remaining with ^{60}Co. All 81 patients in the orthovoltage series (treated from 1951 to 1961) have died of their disease. In the ^{60}Co series 21 out of 81 are still living one to 25 months after completion of treatment. The long-term survival of the orthovoltage series was from 2 to 7 years. Treatment in both series consisted of therapy to the primary tumor and mediastinum and either concurrently or later to the metastatic foci. The primary site was treated with either two or three ports depending upon the size of the patient and the tumor location. In comparing the two types of therapy, injuries from ^{60}Co were less severe. Irradiation sickness was minimal and easily controlled with ^{60}Co, and at no time was it necessary to modify the treatment regimen as was the case with orthovoltage x radiation. Internal reactions such as esophagitis, tracheal and bronchial reactions, and roentgen pneumonitis was about equal in each series, although the tumor dose with ^{60}Co was usually 40% greater. With equal tumor doses the frequency of radiation pneumonitis was higher with orthovoltages, but the biologic effectiveness of the hard γ-ray beam of ^{60}Co was less than that of orthovoltage by about 85%. The most disabling irradiation complication was radiation fibrosis with its resultant diminished vital capacity, but neurologic defects and other serious sequelae have not been detected as yet. (TCO)

15280 RADIOISOTOPE CLINIC. Thomas A. Verdum (U. S. Army Hospital, Landstuhl, Ger.). Med. Bull. U. S. Army, Europe, 19: 68(Mar. 1963).

Facilities and capabilities of the radioisotope clinic at the U. S. Army Hospital, Landstuhl (APO 180, U. S. Forces), are described. (TCO)

15281 OBSERVATIONS ON COLLECTION, STORAGE, AND INFUSION TECHNIQUES OF AUTOLOGOUS BONE MARROW TRANSPLANTATION FOLLOWING RADIO- AND CHEMOTHERAPY IN NEOPLASTIC DISEASES. C. T. Nicolau, V. Apateanu, G. Grigoriu, C. Popovici, I. Birzu, V. Necula, N. Gingold, and I. Jovin (Centrul de Hematologie, Bucharest). Med. Interna, 15: 1417-23(Dec. 1963). (In Romanian)

Techniques are described for obtaining bone marrow

and reinjecting it into the same patient after high-dosage radiotherapy, with reference to 13 patients so treated. In the 13 subjects with inoperable malignant tumors, bone marrow was aspirated from the ilium and sternum by three penetrations of each bone under local anesthesia. About 4 ml of marrow was collected by each insertion, or a total of 0.5 to 15×10^9 cells. The marrow, diluted 1:4 with saline containing heparin (120 units), was mixed with an equal volume of glycerol (15%) in saline. This mixture was frozen in 5-ml tubes at a rate of 1°/min to −15° and then at 4 to 5°/min to −45°C. They were then stored at −80°C for 30 to 60 days. Cell viability tests were conducted with trypan blue. For tumor therapy the patients then received local irradiation of 4000 to 8000 R doses or various chemotherapeutic agents. Leukopenia was successfully prevented in these patients by reinfusion of their own marrow. Reticulocytopenia was also favorably influenced by the marrow infusions, indicating restoration of hematopoiesis by these marrow autografts. Viability of nucleated marrow cells during 60-day storage was about 75%; the deglycerolized marrow was well tolerated by the patients, with only slight transient reactions in two cases. It is concluded that this method is suitable for preventing marrow aplasia in heavily irradiated or drug-treated patients. (BBB)

15282 RADIATION ABSORPTION AND PRIMARY ACRYLATE ENDOPROSTHESES IN GNATHO-SURGERY. Dieter Schlegel and Gustav Wagner. Med. Monatsschr., 16: 28-33(Jan. 1962). (In German)

Compared to the advantages and disadvantages of the usual procedures customarily used for treatment of malignancies of the lower jaw, the combination of primary acrylate endoprostheses with subsequent irradiation appears to be most advantageous. Two main reasons for this are that the radiation absorption coefficient of the plastic is less than that of bone, and because radiation absorption is more uniform in plastic as compared to bone, the dosage to the jaw tissues can be controlled much more closely and accurately. This method, in contrast to partial resection of the lower jaw without primary replacement of the bone sections removed, results in improved functional results. When the lower jaw is to be resected, the area is preirradiated, and antibiotics are administered to prevent infection. After resection a section of plastic is fitted to the resulting bone defect, and the implanted endoprosthesis is irradiated. The plastic does not undergo any structural degeneration that could alter its physicochemical properties. After the irradiation series is completed, the area treated should be kept under observation for at least ½ to 1 yr in order to exclude development of local recurrence of the tumor. (BBB)

15283 EXPERIENCE WITH SETTING UP OF A RADIOLOGIC DEPARTMENT AT AN INTERDISTRICT ONCOLOGICAL DISPENSARY. L. M. Chigirinskii and P. B. Kremer (Volga Regional Oncological Dispensary, USSR). Med. Radiol., 9: No. 11, 45-8(Nov. 1964). (In Russian)

The Volga interdistrict oncological dispensary renders its services to a population numbering 200 thousand, residing within the radius of 200 klms. The radiological department has at its disposal in-patient accommodations with 25 beds (of which 3 are intended for active use), offices for radio-, deep- and close-focus roentgenotherapy, telegammatherapy and x-ray diagnosis. Experience gained in setting up the radiological department is described. (auth)

15284 THE MEASUREMENT OF THE TOTAL RADIOACTIVITY OF THE BODY IN MEDICAL DIAGNOSIS. B. Malamos (Athens Univ.). Muench. Med. Wochschr., 105: 1533-8(Aug. 2, 1963). (In German)

The technique of whole-body counting of radioisotopes for medical diagnosis, clinical metabolic studies, and laboratory studies can replace other methods that are based on excretion measurements. The whole-body counting technique also is easier to carry out rapidly and accurately. This increases the numbers and types of studies that can be made. A whole-body counting system, consisting of a single 3 × 4 in. scintillation detector, a 256-channel pulse height analyzer with cathode tube display, pen recorder, and printout facilities was used to study several clinical problems. These included measurements of ^{59}Fe absorption after oral administration, measurements of ^{58}Co-labeled vitamin B_{12} absorption, studies with ^{82}Br of extracellular fluid volume changes induced by diuretics, measurements with ^{22}Na of total exchangeable Na, and studies of protein turnover with ^{131}I-labeled human serum albumin. (BBB)

15285 RADIODIAGNOSIS, RADIOTHERAPY, AND RADIOPROTECTION, 2ND HALF YEAR, 1963. Friedrich Ekert. Muench. Med. Wochschr., 106: 1742-9(1964). (In German)

Pyelography is a procedure that is often recommended when a high dose of radiation is to be administered for genital carcinoma in women. Provided that there is no hypersensitivity to the contrast medium to be used, it can be carried before or just prior to the irradiation, and will help to ascertain whether there is any ureteral obstruction present. Irradiation of the genital organs should not be regarded as a simple procedure, even though it is less complex to carry out in a stationary field than in a moving field. In a stationary field there are relatively few possibilities for variation, and doses are usually lower than those given in moving irradiation. More accurate geometric measurements also are necessary in moving irradiation. Procedures such as angiography or lymphography may provide information as to the location of metastases so that they can be included within the radiation fields. (BBB)

15286 DIFFERENTIAL CONCENTRATION OF ARSENIC-74 AND COPPER-64 IN EXPERIMENTAL LESIONS IN CAT BRAINS. H. Hacker, S. Aronow, and A. H. Soloway (Massachusetts General Hospital, Boston). Neurochirurgia (Lima), 7: 100-5(May 1964).

Studies were made on the effects of concentrations of ^{74}As and ^{64}Cu on processes in the peripheral areas of the brain surrounding focal lesions in the cat. External localization of intracranial lesions by radioisotopic scanning procedures was essentially pragmatic in approach. A beginning was made toward understanding physiological and biochemical mechanisms involved in the concentration of radioisotopes in pathological areas of the brain. Cats were used in which both ultrasonic and pressure lesions were generated and isotopic levels in the lesion site, areas peripheral to the lesion and normal brain were determined. An hypothesis is proposed for the mechanism by which a lesion is located. From the results it appears that the cat is a better model than the mouse for evaluating trace materials for human brain scanning. (P.C.H.)

15287 FUNDAMENTAL STUDIES ON THE EXTERNAL BETA RADIATION OF RADIOPHOSPHORUS(^{32}P). Tatuo Takahashi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gokkai Zasshi, 22: 130-76(May 25, 1962). (In Japanese)

In external β irradiation methods with radiophosphorus, ^{32}P-treated filter paper is placed on the affected area. To give homogeneous radiation effects on the whole affected area the ^{32}P-treated paper is made the same size as that of the area. However, it is difficult to obtain such an ideal homogeneous effect of the treatment. An experiment was conducted to determine the dose-distribution in the affected area, according to the size and the form of the ^{32}P-treated paper. Filter paper was immersed in the ^{32}P solution and dried. Using these ^{32}P-treated papers, x-ray films were irradiated with various doses through a phantom of paraffin and vinyl plastic. The irradiation doses at various depths of the phantom were measured by densitometry of the blackened film exposed to ^{32}P. The dose distributions in the phantom were measured by a scintillation counter. The dose in the central part of the irradiated field increased with the increase of the width of the paper. When the area of the paper reached a certain limit, the dose in the peripheral part is reduced more than that of the central part. The self-absorption of the ^{32}P-treated paper at 30 $\mu C/cm^2$ density was so small that the dose and the density were related in a proportional way. When a wide paper is used,

the dose in the central part of the field is larger in comparison with that with a small paper. The dose distribution in the irradiated field is not homogeneous, showing in the center a larger dose and a smaller one in the periphery, but this difference of the dose distribution is not improved even when a smaller ^{32}P-treated paper is used. This lack of homogeneous dose distribution is an obstacle for clinical applications. (BBB)

15288 X IRRADIATION IN THE TREATMENT OF HYPERTHYROIDISM. Hideo Irie, Keiichio Onizuka, Tatsuo Maeda, Shigeaki Okamura, Katsushi Watanabe, Shigeki Momii, and Kyoichi Fujii (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 786-91(Sept. 1963). (In Japanese)

Because of various complications associated with the use of radioiodine for the treatment of hyperthyroidism, a technique using 170-kv x rays was explored. With radioiodine it is difficult to administer the precise radiation dose to the gland because the estimation of the gland size and uptake of a therapeutic dose of radioiodine, which may be different from that of the tracer dose, is imprecise. Consequently, after radioiodine treatment there is a great possibility of hypothyroidism and danger of recurrence of the neoplasm. Therefore, external x irradiation of the gland was given with a tangential technique employing 50 R initially and increasing the dose until it reached 100 to 150 R. Frequency of irradiation was once a week. The basal metabolic rate as well as the iodine uptake of the thyroid gland was repeatedly measured to prevent the development of hypothyroidism. Usually therapy was discontinued when the basal metabolic rate dropped to a +20% value. Experience with 19 cases of hyperthyroidism treated by this external irradiation technique is described. Of these 19 patients, nine became euthyroid and eight remained hyperthyroid but showed marked improvement. One case showed no change. There was no cases of hypothyroidism and recurrence was seen in two cases only. (BBB)

15289 DOSE DISTRIBUTION OF RADIATION THERAPY. PART II. TUMOR VOLUME DOSE RATIO. Tadashi Miyakawa and Yuh Iino (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 893-906(Oct. 1963). (In Japanese)

The tumor volume dose ratio R is defined as the volume dose of tumor divided by the volume dose of total body. The tumor volume dose ratios for surface irradiation, contact irradiation, and interstitial implantation are discussed. By assuming that the cross section of the human body was a fan-shape, volume doses were obtained for the contact and surface irradiations. For surface irradiation with radium, the volume dose for the tumor was obtained using the results of Paterson and Quimby. For interstitial implantation, R was obtained for a radium needle; it was limited to the case in which the radium was placed on the axis of the cylinder. The R's were also obtained for therapy of the thyroid cancer with I-131, P-32 (leukemia), Y-90 and Au-198 colloid. In the case of Y-90 and Au-198 colloid, the effect of penetration of the β rays to the periphery of the lesion was important, and mathematical evaluations of this effect were made. In studying the dose distribution in the space for the various radiological procedures, the following three factors should be included: the % depth dose (P), the tumor volume dose ratio (R), and the tumor dose distribution homogeneity ratio (σ). It may be possible to evaluate the various irradiation procedures by the function $f(P,R,\sigma)$, which reflects the biological significance of each of these factors. (auth)

15290 STUDIES OF BIOLOGICAL SIEVE EFFECTS. Hiromu Kaneda, Morimasa Maeda, Toyohiko Hishida, and Jiro Nakatsuka (Kyoto Prefectural Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1013-20(Nov. 1963).

It is generally accepted on a clinical and experimental basis that sieve therapy, in which x rays are delivered fractionally in space, causes less radiation hazards to normal tissue than conventional irradiation therapy. Previous studies in this series on superficial sieve effects on rabbit testis by a fine sieve with openings 2 mm in dia, permitting 40% of direct beam to pass, indicated that the degree of injury of various germ cells irradiated with the sieve method was always less than with the conventional method and that this injury with both methods was most marked ten weeks after irradiation at a single dose of 600 R. The present experimental studies deal with biological effects of sieve irradiation at various depths of rabbit testis. A lead sieve with 2.0 mm diameter perforations was used, with an open/shielded area ratio of 4/6. A dose rate of 112.4 R/min with 200-kv x rays was given the testis. Paraffin blocks of 5- and 10-cm thickness were placed over the testis to obtain depth effects. A local dose of 600 R to the testis under a 5-cm paraffin block with an air dose of 800 R was required if a sieve was not used; to obtain an average local dose of 600 R with a sieve, 2000 R was required as an air dose. In case of a 10-cm paraffin block, 1622 R was required as an air dose without the sieve and 4050 R with the sieve. No injuries to the Sertoli's cells irradiated with a single dose of 600 R were observed and the numbers of the cells of the specimens were within 5% those of controls at any time after irradiation. The percentage of Sertoli's cells was obtained by dividing their number by the number of germ cells. The various cell numbers with the sieve method were always larger than with the conventional method. There was a difference within 5% at a 5-cm depth but no significant difference at a 10-cm depth of paraffin. Considering that the ratio of germ cells for the sieve and nonsieve techniques at a 10 cm depth is 1.17, it is apparent that no specific biological sieve effects resulted at a 10-cm depth. Since a physical ratio of the maximum to the minimum dose, viz., an inhomogeneity quotient for the open area to that for the covered area is 6.8 on the surface, 2.2 at a 5-cm depth, and 1.8 at a 10-cm depth, it is considered that specific biological sieve effects do not obtain in the living animal in which the inhomogeneity quotient of dose distribution proves less than 2. In a second experiment the survival of male mice of the ddN strain x irradiated with the same local dose at different depths under a paraffin block was observed. They were subjected to whole-body irradiation with local doses of 600, 800, and 1000 R. The 30-day survival rate of one group which was irradiated at a 2-cm depth was 26.6% and that of another group at a 7-cm depth was 13.3%, revealing that the same local dose resulted in a higher survival rate for surface irradiation than deep irradiation. Hence, the larger the local dose, the shorter the survival period. However, in all cases the survival of mice irradiated with a sieve was higher than that without a sieve. In the third experiment male guinea pigs were employed with variation of size of the opening of a sieve in telecobalt therapy. The sieve was made of lead 4.6 cm in thickness, perforated with cylindrical holes of 1 cm dia. Whole-body irradiation was given to the guinea pigs at a local dose of 400 R which was delivered to the surface or at 5-cm and 10-cm depths of paraffin block. The survival rate a month after 400 R irradiation at the surface was 46.7%, at a 5-cm depth 33.3%, and at a 10-cm depth 13.3%. Thus the theory that the higher the inhomogeneity the more marked the biological sieve effect was confirmed by these results which verified that the shallower the irradiation the higher the survival rate in the sieve irradiation. (BBB)

15291 THE INFLUENCES OF THE STRUCTURE OF A TELECOBALT SIEVE TO INHOMOGENEITY QUOTIENT AND MEAN DEPTH DOSES. Morimasa Maeda (Kyoto Perfecture Univ. of Medicine) and Tadashi Imamura. Nippon Igaku Hoshasen Gakkai Zasshi, 24: 395-403(July 1964). (In Japanese)

The relation between the inhomogeneity quotient and the structure of a sieve is more complicated in telecobalt sieve irradiation than in x-ray sieve irradiation. To elucidate this relation, the data from 12 sieves of different hole diameter and different area ratio reported by Mauderli, et al., were quoted and analyzed, and the depth doses of three kinds of sieves (our clinic, Osaka Railway Hospital, and Gifu Hospital) measured with a fluoroglass dosimeter were compared. It was found that the larger the hole diameter, the smaller the area ratio, the smaller the ^{60}Co source diameter, and the greater the thickness of the lead is, the larger becomes the inhomogeneity quotient. The dis-

tance between the ^{60}Co source and the sieve also has great influence on the inhomogeneity quotient. These complicated influences of the structure of a telecobalt sieve were thoroughly analyzed by the method of U calculation (Utilization of ^{60}Co source). To detect the relation between these structural components, a formula was derived, which is thought to be useful in the planning of a new sieve. Respective mean depth doses in telecobalt sieve irradiation may be defined as the product of M (mean transmission of a sieve) multiplied by the depth doses of homogeneous irradiation. Mean depth doses calculated showed very excellent coincidence with those measured with a flat chamber. (auth)

15292 POST-IRRADIATION CHANGES AND DOSE DETERMINATIONS IN THORIUM-IMPREGNATED LIVER AND SPLEEN. A CASE REPORT. Noritoshi Watanabe and Tatsuo Mandai (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 493-501(Aug. 1964).

A brief review of the history of the use of thorium dioxide is presented. Some of the difficulties encountered in estimating amounts of thorium in impregnated tissue and making dose calculations are cited. Results of chemical analysis and radiographic and autoradiographic studies of tissues of a patient who received intravenous injection of thorotrast 22 years ago are also presented. Estimates of dose to the liver and spleen of this individual were 680 and 25,000 Rem respectively. (auth)

15293 STUDY OF THE BLOOD COAGULATION WITH RADIUM IRRADIATION. E. (=A.) Szirmai (Div. of Nuclear Hematology, London-Stuttgart). Nucl. Hematol., 4: xvi-xvii(Dec. 1964-Feb. 1965). (In German)

Coagulation experiments made on 82 gynecological carcinomatous patients before and after x irradiation showed no relation between the age and general health of the patient and the site and stage of the carcinoma on the one hand and between individual coagulation factors on the other hand. This was partially explained by the fact that the radiation dose and the time elapsed from the irradiation to the coagulation phase affect individual patients differently. Factors of the nervous systems and kinase appearing in the blood stream as a result of radioinduced tissue anoxemia in tissue decomposition also play a role in the coagulation behavior. (tr-auth)

15294 COMBINATION OF IRRADIATION AND WERTHEIM'S HYSTERECTOMY IN TREATING CERVICAL CARCINOMA. John H. Holzaepfel and John C. Ullery (Ohio State Univ., Columbus). Postgrad. Med., 35: 143-4 (Feb. 1964).

A combination of 5000 R ^{60}Co irradiation therapy six to 10 weeks before radical hysterectomy was used in 140 cases of stage I or stage II carcinoma of the cervix. The results indicated that it is superior to irradiation alone. Five-year survival rates for the patients with stage I and stage II lesions were 85.7 and 70.3%. In comparison, the five-yr survival rate for patients with stage I lesions treated by irradiation alone was about 70% and the corresponding figure for stage II was 30%. Among patients with irradiation therapy alone the rate of central recurrence was 16% for stage I and 33% for stage II; however, many of these patients did not receive adequate treatment initially. Wertheim hysterectomy yielded five-year survival rates of 89% (stage I) and 60% (stage II) among patients who had positive nodes. (BBB)

15295 SOME APPLICATIONS OF MEASUREMENTS OF WHOLE-BODY RADIOACTIVITY IN CLINICAL MEDICINE. D. Hughes, P. R. J. Burch, and A. R. Wilson. Postgrad. Med. J., 40: 147-8(Mar. 1964).

Historical aspects of whole-body counter development, specifications of the University of Leeds counters, and their applications in medical research are presented. In diuretic therapy, 1 g of chlorothiazide administered daily to 12 normal volunteers produced a fall in serum K level but no significant change was observed in the whole body K. To compare the total-body counting method with the excretion method, doses of 1.5 μC ^{47}Ca were administered to seven subjects and, at the end of one week, the activities in the body, and in the total collected urine and feces were measured. Summation of the three measurements was within the limits of 0.89 to 1.10 times the administered dose. Measurements are also being made of the uptake and retention of ^{59}Fe in obscure iron-loading anemia. (TCO)

15296 BEAM THERAPY APPARATUS IN A MODERN RADIOTHERAPY DEPARTMENT. Frank Ellis (Churchill Hospital, Oxford). Proc. Roy. Soc. Med., 57: 349-50(May 1964).

Optimally the right apparatus should be able to deliver a minimum tumor dose, or a uniform dose to the volume to be treated with a minimum dose to normal tissues. The distribution of radiation in the beam should be symmetrical about its axis, and the isodose curves reasonably flattened. The apparatus should have incorporated in it devices to avoid any mistakes in delivering the prescribed dose. For skin diseases, Grenz-ray apparatus should be available so that damage to deeper structures is avoided. For superficial malignant conditions, so-called contact (40–60 kv) and superficial (75–140 kv) x-ray apparatus are both desirable. For deeply situated or extending malignant conditions, deep x-ray apparatus (200–300 kv) and high-energy apparatus (^{60}Co and 2–70 Mev x-ray apparatus) may be used. There are several advantages of high-energy apparatus. Even if high-energy beams are available, a deep x-ray apparatus is also useful. Accurate shielding with small thicknesses of lead is possible with deep x rays, while the greater thicknesses and greater penumbra implicit with higher energy beams may cause difficulties in shielding. It was concluded that one of every type of apparatus should be available, up to the high-energy range, and that in this range one x-ray apparatus and one ^{60}Co machine are necessary in a center with 1000 new malignant cases annually, having to treat about 700 with such apparatus per year, including palliative cases. (TCO)

15297 EXPERIENCES IN THE LOCALIZATION OF INTRACRANIAL TUMORS WITH ^{203}Hg. J. W. D. Bull (National Hospital, London). Proc. Roy. Soc. Med., 57: 1049 (Nov. 1964).

When using ^{203}Hg, a kidney blocking dose of 1 ml meralluride is given 24 hr before the examination. The radiation dose received by the kidneys from the subsequently given isotope is thereby reduced three-fold. Even so, the dose is not negligible, amounting to about 60 rad. The ^{203}Hg is given the following day, about 10 μC per kg being injected intravenously. The scan is taken about five hr later, with the patient's head in the lateral position relative to the scanner. A lateral scan takes about 45 min. If a lesion is found anteriorly in the head, the patient is then scanned in the supine position. If the lesion lies posteriorly, the examination is made in the prone position. In the 100 cases examined and analyzed the findings were: positive 50, equivocal 7, negative 43. The positive cases consisted of astrocytomas (all grades of malignancy) 23, metastases 11, meningiomas 8, miscellaneous 8. There were no false positives. Among the negative scans, 15 were later proved to be false. There were probably 22 true negative cases. (BBB)

15298 THE USE OF RADIOPHOSPHORUS UPTAKE TO CONTROL THE RADIOTHERAPY OF INTRACRANIAL TUMORS. R. Tudway (Bristol Royal Hospital, Eng.). Proc. Roy. Soc. Med., 57: 1050(Nov. 1964).

A method is described of controlling the activity of undifferentiated cerebral gliomata, within restricted limits, by means of chemotherapy, and then attempting to use this control to potentiate the effectiveness of deep x-ray therapy. In the first instance, a miniature Geiger counter is implanted into the tumor by a neurosurgeon. The instrument is 3 mm in dia and under 6 cm long. After insertion of the counter a dose of tracer ^{32}P is given and a continuous record is made of the count rate during the whole procedure. This count rate is presumed to run parallel to the metabolic activity of the growth. A period of quiescence followed by peaking of activity is induced, by giving methotrexate, or a similar agent for a few days. Deep x-ray therapy is then administered to the growth at the time of the peaks. Out of the first 8 cases, 4 were inconclusive. Three were

very advanced and the patients died in a few days, before deep x-ray therapy began; in another the Geiger counter failed. Of the 4 cases in which treatment was concluded, 2 died within three months and 2 were well at the end of that time. The method is being investigated further in the hope that potentiation of sensitivity of the growth will obviate the dangerous effects of high doses of radiation on the normal brain tissue; in addition, improvements in the local treatment of advanced and inoperable gliomata will be doubly valuable because distant metastases do not occur. (BBB)

15299 THE TREATMENT OF THYROCARDIAC DISEASE WITH RADIOACTIVE IODINE. Solomon Silver, Clement Delit, and Milton Eller (Mount Sinai Hospital, New York). Progr. Cardiovascular Diseases, 5: 64-80 (July 1962).

Data are presented on the results of radioiodine therapy of 1603 patients with hyperthyroidism, some with associated heart disease, with reference to the doses required and the complications. Among this group there were 187 with congestive failure, 30 with angina pectoris, and 32 with both congestive failure and angina pectoris. In addition, there were 107 patients with atrial fibrillation but without congestive failure or angina. Each patient was treated until the hyperthyroid state was completely controlled. In general, somewhat larger doses of ^{131}I were given to the thyrocardiacs. The total number of treatments varied from 1 to 8; 49% of the entire series received one dose, as did 48% of the cardiacs. The remaining cardiacs were controlled with 2 to 5 doses. Although the average administered dose for the cardiac patients was over 60% greater than for the entire series, 11.5 mC compared to 7.0 mC, a significant number of the cardiac patients was controlled with relatively small doses of ^{131}I. There was striking improvement in all types of thyrocardiac disease as a result of ^{131}I therapy. Angina and uncomplicated atrial fibrillation were relieved in almost 100% of the cases. The permanent myxedema rate for the entire series was 7% and for cases of angina pectoris 13%. The recurrence rate was 0.75% for the entire series and 1.2% for the cardiac group. (TCO)

15300 SURVEY OF RADIUM SOURCES IN OFFICES OF PRIVATE PHYSICIANS. Thomas M. Gerusky, Joel O. Lubenau, Robert Roskopf, and Jan Lieben (Dept. of Health, Penna.). Public Health Rept. (U. S.), 80: 75-8(Jan. 1965).

A survey of 54 private practitioners in Pennsylvania using radium revealed a need for control procedures. Failure to provide for periodic leak-testing was the most common deficiency. None of the 54 had conducted annual leak tests. The radium of 24 physicians was improperly stored, and many facilities required extensive decontamination. Health department personnel had to conduct a search to locate the radium source of one deceased physician. These results reaffirm the need for continuing and scheduled surveillance of radium and radium users. (auth)

15301 A TRANSLUCENT MEDIUM FOR BIOLOGICAL SHIELDING: ZINC BROMIDE FOR A TREATMENT-ROOM WINDOW. M. Miller. Radiography, 29: 378-80(Dec. 1963).

Viewing a patient under treatment can be controlled by a selection of three methods: by direct viewing through a window in the wall of the treatment room; by mirrors and lenses operated at a control panel outside the treatment room; and by closed television circuit controlled by the operator. The requirements of a viewing medium are described. Solids have been used successfully as viewing media. Of these only glass is important, and special glasses stable to radiation and temperature gradients have been developed. Many liquid media have been tried, including high density organic chemicals, but of all these liquids, only zinc bromide satisfactorily complies with all the requirements for direct visual acuity and biological shielding and then only when strictly controlled in manufacture. The use of zinc bromide as a biological shielding agent is described. It has many advantages including the high degree of visual acuity, low installation costs and maintenance, and it requires no complicated apparatus or equipment to use. (TCO)

15302 RESULTS OF TELECOBALTOTHERAPY IN CANCER OF THE BLADDER. S. Casara, G. Conte, G. Mobilio, and R. Ravasini (Ospedale Civile, Padua). Radiol. Med. (Turin), 50: 1230-40(Dec. 1964). (In Italian)

After reviewing the different therapeutic indications that arise in relation to the stage of the process, and illustrating the technique of telecobaltotherapy of the vesical area, a case-list of 179 patients with cancer of the bladder, subjected to telecobaltotherapy is presented. The case-list analyzed with regard to the local complications observed during and after radiant treatment and to the results obtained. It is pointed out that while too low doses exclude the possibility of obtaining recovery, too high ones do not make it any more probable and comprise the risk of causing serious damage to the bladder. Therefore the administration of doses between 4000 and 6000 Rad, distributed over 4 or 5 weeks, in telecobaltotherapy of cancer of the bladder is suggested. (auth)

15303 INTRACAVITARY IRRADIATION OF THE BLADDER WITH RADIOACTIVE β-EMITTING RUBBER BALLOON CATHETERS. Hans H. Zinsser, Jane Wolf, Elizabeth Wertz, Aurelio Uson, William Goodwin, Maki Al Waidh, and Henry Azar (Columbia Univ., New York). Radiology, 84: 428-35(Mar. 1965).

Observations in 24 dog bladders that were irradiated by the β-emitting rubber balloon catheters at various levels are given. Below 1,000 Rads there were no significant changes. Above 7,000 Rads, the damage was severe, involving total loss of the mucosa. For the 2,000 to 4,000 Rad level, the picture was one of alteration with a subsequent healing. This range could be safe and useful in clinical applications. It is emphasized that this is a technic with restricted application. It offers a useful alternative in papillomatosis, i.e., early, noninfiltrating bladder-papilloma, and may have an application in gastric balloons for hyperacidity. (C.H.)

15304 DETECTION OF SOURCE MISALIGNMENT IN COBALT-60 TELETHERAPY UNITS. Herbert L. Jackson, Howard B. Latourette, and Loren Holm (State Univ. of Iowa, Iowa City). Radiology, 84: 443-6(Mar. 1965).

Attention is directed to the possibility of beam misalignment in certain types of ^{60}Co teletherapy units, and its effects on dose distribution. The discussion applies primarily to teletherapy units with the source attached to a wheel that rotates 180° to carry the source from the off to the on position. Methods of detection and correction are suggested. (P.C.H.)

15305 A FOUR-YEAR EXPERIENCE WITH TOTAL-BODY IRRADIATION. Melville L. Jacobs and Fred J. Marasso (Hope Medical Center, Duarte, Calif.). Radiology, 84: 452-6(Mar. 1965).

Results of four years experience with whole-body irradiation on 52 patients are reported. No serious complications of the treatment program were experienced. It was concluded that whole-body irradiation has some usefulness, but it is limited. However, it is believed that there is reason to continue the evaluation of whole-body irradiation soundly and on a good statistical basis, although this has been found difficult to achieve as yet. (P.C.H.)

15306 A NEW AGENT FOR SPLENIC SCANNING: BMHP. Millard N. Croll, Luther W. Brady, Isadore Brodsky, and Leonard Stanton (Hahnemann Medical Coll., Philadelphia). Radiology 84: 492-5(Mar. 1965).

A new agent for splenic scanning, mercury-203-labeled-bromo-1-mercuri-2-hydroxypropane, was studied. The critical organ for radiation dosage is the kidney. Mercury-197 was substituted as the label to decrease the renal hazard. ^{197}Hg-1-mercuri-2-hydroxypropane proved to be more easily prepared and clinically good for splenic scanning. This method yields splenic scans of good diagnostic quality. (auth)

15307 A COMPARISON OF RESULTS OF BRAIN SCANNING USING Ga^{68}-EDTA AND THE POSITRON SCINTILLATION CAMERA, WITH Hg^{203}-NEOHYDRIN AND THE CONVENTIONAL FOCUSED COLLIMATOR

SCANNER. Alexander Gottschalk, Kenneth R. McCormack, John E. Adams, and Hal O. Anger (Univ. of California, Berkeley). Radiology, 84: 502-6(Mar. 1965).

Comparison was made between conventional photoscanning with a gamma-emitter and scintiphotography with the scintillation camera, employing a positron-emitter. Several hypotheses are suggested. When one or both techniques failed to demonstrate a tumor, the major tumor type involved was that of astrocytoma. Successful localization of this tumor type was achieved in more instances with ^{68}Ga-EDTA and the positron scintillation camera. ^{203}Hg-Neohydrin was more tumor-specific than ^{68}Ga-EDTA. The latter, because of its extracellular distribution, detects other diseases such as inflammatory and other vascular pathology not evident on ^{203}Hg-Neohydrin scans. In this series, arachnoiditis and neuritis produced abnormal studies with ^{68}Ga-EDTA. Positron-imaging with the scintillation camera may be more sensitive in detecting midline tumors than conventional scanning with a gamma-emitter. The relatively short examination time and reduced body radiation dosage with the ^{68}Ga-EDTA technique will permit repeat studies of questionable lesions and more follow-up studies of treated cases. (P.C.H.)

15308 REPORT OF A CASE WHERE A RELATIVELY INCIPIENT GASTRIC CANCER RECEIVED PREOPERATIVELY LARGE Co-60 IRRADIATIONS AND WAS PARTIALLY HEALED WITH SCAR FORMATION. Tatsuo Takahashi and Shoziro Izumi (Yuri Kumiai General Hospital, Akita, Japan). Rinsho Hoshasen, 8: 781-5(Oct. 1963). (In Japanese)

A patient was diagnosed as having a relatively incipient gastric cancer by x-ray examination and irradiated with telecobalt as the preoperative treatment. The patient was irradiated for 12 days at 300 R at a time to a total dosage of 3000 R, and the feeling of swelling in the gastric region and other complaints disappeared. The patient refused the operation. The patient was irradiated again, starting 65 days after the end of the first irradiation. This second irradiation was done at 200 R at a time for 35 days to a total dosage of 5200 R. His condition became better and x-ray examination showed some healing. One and two months after the end of the second irradiation, the patient had again complaints of swelling in the gastric region and languor in the whole body, so re-irradiation of the region was started at 200 R at a time. When the total dose reached 1000 R, a perforation occurred in the stomach and the patient was immediately operated. The operation showed scar formations in the primary lesion and metastatic lymph nodes. The perforation was thought to have been caused by the large irradiations. The histological findings showed that the change and damage of the cancer cells was slight and treatment by telecobalt alone was insufficient. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

15309 THE USE OF PROTEIN ANABOLIC HORMONE IN THE RADIOTHERAPY. Shinji Suzuki and Takeo Takano (Keio Univ., Tokyo). Rinsho Hoshasen, 9: 91-7(Feb. 1964). (In Japanese)

In the radiotherapy of malignant tumors, the administration of Anadrol (protein anabolic hormone) is desirable because this increases the patient's appetite and body weight and improves other physical conditions. It is also effective in preventing radiation sickness. The radiotherapy, together with the administration of Anadrol, is effective in the treatment of bone metastasis (especially, osteolytic type), since it accelerates the re-precipitation of Ca to the bone metastasis. Side effects from the administration of Anadrol are not clearly observed, even for large doses and long durations of the administration (2700 mg, about 3 months). Transient edema and oliguria were seen only in 3 of the 19 cases. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

15310 PRELIMINARY HISTOLOGIC OBSERVATIONS OF MALIGNANT LYMPHOMAS TREATED WITH INTRALYMPHATIC INJECTION OF LIPIODOL F ^{131}I. Sergio Chiappa, Guido Galli, Michele Guarino, Severino Barbaini, and Gianni Ravasi (Universita, Milan). Tumori, 49: 87-106(Mar.-Apr. 1963). (In Italian)

Eighteen cases of lymphosarcoma, reticulum cell sarcoma, and Hodgkin's disease were treated for 45 days with Lipiodol F ^{131}I (radioactivity not higher than 10 to 12 mC). This dose was introduced through the lymphatic vessels, giving a lymph node dose of 200 to 3600 rad, with an average of 842 rad. The most significant changes consisted of destruction of neoplastic cells, stromal reactions, with hystiocyte and giant cell formation. These changes were of various degrees, according to the type of tumor and the dose of Lipiodol F ^{131}I injected. The main histologic feature in the lymph nodes in lymphosarcoma was the total necrobiosis of the neoplastic tissue. In contrast, reticulosarcoma presented a lower degree of lymph node reaction and reduction of reticulopoietic activity. In malignant lymphogranuloma, the empty cavities produced were round and confluent. The histologic modifications varied according to the quantity of Lipiodol injected, the specific activity of Lipiodol F ^{131}I, and the time between treatment and biopsy observations. It is emphasized that although in come cases the regression of the neoplastic tissue was not complete and therefore not totally destroyed, the general results confirmed the effectiveness of intralymphatic radiotherapy with this radioactive agent. (BBB)

15311 IONIZING RADIATION. Alfred J. Thiel. X-ray Technician, 34: 365(May 1963).

Recommendations are made to radiologists and x-ray technicians for informing their patients of the low level risk involved in diagnostic tests. It is believed that, with the proper knowledge of x-ray equipment, i.e., cones, collimators, filters, and exposure factors, the radiologist can apply radiation so the benefits outweight the adverse effects. How to answer questions from patients who are concerned about the ionizing radiation they will receive during the course of an x-ray examination is considered. It should be pointed out that the exposure is small, and the x-rays will be directed only to the region that needs to be examined. It can also be mentioned that the advantages to be gained from a properly performed x-ray examination far outweigh any adverse effects. It may also be helpful to explain how exposures are made by regulating the kilovoltage, milliamperage, and distance, so as to use the least possible amount of x ray to obtain high quality film. The aluminum filter and collimator or cone can be pointed out, explaining the limiting effects of each. (TCO)

15312 X IRRADIATION OF THE PITUITARY REGION IN DIABETIC RETINOPATHY. A. Kahan, G. Csapo, E. Sovenyi, and S. Szues (Medical Univ., Szeged). Z. Klin. Med., 157: 499-509(Nov. 8, 1963). (In German)

Clinical results and complications following irradiation of the pituitary in 31 diabetic patients with retinal disease are described. Daily 200-R doses of 180-kv x rays were given to attain total doses of 4000 to 4800 R (skin doses). Changes in the eye grounds were examined during and after irradiation. The effects of pituitary irradiation on insulin requirement, blood sugar levels, and urinary 17-hydroxycorticoid and 17-ketosteroid excretion were also determined. The deteriorating visual acuity of the patients seen in the pre-irradiation period was ameliorated in 57% and remained stationary in 17% of the cases. There were no significant endocrine changes. Regression of microaneurysms, hemorrhages, and proliferative changes were the first and most frequent findings. The most favorable response was observed in cases of proliferative retinopathy, without signs of arteriosclerosis and with early onset in life, in which preirradiation visual acuity was around or below 0.1. In eight patients the insulin requirement was reduced after irradiation and in one case treatment with insulin was no longer required. The urinary excretion of 17-ketosteroids was diminished in about ⅓ of the patients after irradiation but that of total 17-hydroxycorticosteroids was unchanged. It was concluded that x irradiation of the pituitary is as effective as, and free of dangers of, hypophysectomy for treatment of diabetic retinopathy. (TCO)

15313 ATOMIC MEDICINE. FOURTH EDITION. Charles F. Behrens and E. Richard King. Baltimore, The Williams and Wilkins Company, 1964. 778p. $18.00.

Separate abstracts were prepared on twenty-four chapters. Two chapters were abstracted previously and appeared in NSA Vol. 18 as number 37017 and Vol. 19 as number 226. (C.H.)

For abstracts of individual chapters see: 15005, 15006, 15207, 15208, 15209, 15210, 15211, 15212, 15213, 15214, 15243, 15314, 15315, 15316, 15317, 15318, 15319, 15320, 15321, 15322, 15323, 15324, 15325, and 16323.

15314 THE DOSIMETRY OF INTERNALLY ADMINISTERED RADIONUCLIDES. Thomas G. Mitchell. p.371-402 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Factors affecting radiation dose estimations for internally administered radionuclides are discussed. Nuclear data for 38 medically useful radionuclides are tabulated and formulae and methods for dose calculations from α particles, β particles, low-energy x radiation, γ radiation, and positrons are presented. Topics discussed include radiation units, radioactive decay, the relation of activity to time, effective half life of radioactive atoms in a biological system, decay constants, geometrical factors used in dose calculations, β particle dosimetry, γ ray dosimetry, and the dosimetry of combined β and γ radiation. (C.H.)

15315 THE USE OF RADIOACTIVE ISOTOPES IN SCANNING PROCEDURES. Harold L. Endlich. p.417-42 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The principles involved in radioisotope scanning include the detection and mapping of the spatial distribution of an isotope within an organ. The medical importance of scanning is derived from its use in the determination of organ size and shape and the high degree of accuracy in demonstrating pathology without risk or discomfort to the patient. Recent improvements in radiation detection equipment and radiopharmaceuticals for use in scanning are discussed. Applications of radioisotope scanning procedures for the visualization of the thyroid gland, liver, brain tumors, spleen, lymph nodes, heart, kidneys, pancreas, and bone growth, repair, and neoplasms are described. (56 references.) (C.H.)

15316 RADIOIODINE IN THE DIAGNOSIS OF THYROID DISEASE. Ralph R. Cavalieri. p.443-74 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Applications of radioisotopes of iodine in thyroid function tests are discussed. Although ^{131}I has proved to be the most convenient single radioisotope for both the diagnosis and therapy of thyroid diseases, ^{123}I, ^{125}I, ^{127}I, ^{128}I, and ^{132}I offer advantages of their own. The physiological and biochemical bases for the various radioisotope thyroid function tests are reviewed and the advantages and limitations of each are pointed out. (C.H.)

15317 HEMATOLOGICAL STUDIES UTILIZING RADIOISOTOPES. Howard A. Pearson. p.475-90 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Isotopic procedures are described for use in investigations of erythrocyte synthesis, survival, and destruction. The procedures include the use of 3 isotopic preparations of vitamin B_{12} using ^{57}Co, ^{58}Co, or ^{60}Co as the tracer, for the diagnosis of megaloblastic anemias; erythrocyte and platelet survival studies using $Na_2{}^{51}CrO_4$; ^{32}P-diisopropyl fluorophosphonate, glycine labeled with ^{15}N or ^{14}C, acetate labeled with deuterium, and ^{59}Fe and ^{55}Fe as a label; and investigations of hemoglobin synthesis and turnover using ^{55}Fe and ^{59}Fe separately or in two simultaneous Fe studies. It is pointed out that although these tests are more important as investigational tools, they also provide clinical information that cannot be obtained by conventional hematological methods. (44 references.) (C.H.)

15318 THE BLOOD VOLUME. Solomon N. Albert. p.491-502 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Application of radioisotopes for measuring circulating blood volume, based on the dilution principle, are discussed. A known quantity of tracer material is introduced into the blood stream, and, after allowing 5 to 10 min for mixing, a sample of blood is removed and quantitatively analyzed to determine the content of the tracer in blood. Protein bound tracers are used to measure plasma volume and cellular bound tracers are used to measure erythrocyte volume. Iodinated serum albumin labeled with ^{131}I is most commonly used for measuring the plasma volume and the blood volume, although ^{131}I-globulin, ^{125}I-albumin, ^{59}Fe-citrate, and $^{51}Cr-Cl_3$-chromic chloride have also been used. Erythrocytes labeled with ^{51}Cr are most commonly used for measuring erythrocyte volume, although erythrocytes labeled with ^{59}Fe, ^{32}P, and ^{42}K have also been used. Methods used for blood volume studies are described and evaluated. It is pointed out that differences in evaluating norms for blood volume stem from the various methods employed for measuring blood volume and the body parameters used in the calculations, such as body weight, lean body weight, height and weight, height and weight squared or cubed, or surface area. Norms vary according to age, sex, environment, and physical activities, and may be changed by pathological conditions. Optimal values for normal blood volume are tabulated. (24 references.) (C.H.)

15319 RADIOISOTOPE STUDIES OF THE GASTROINTESTINAL TRACT. William H. Fleming. p.503-28 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Radioisotope techniques for studies of gastrointestinal tract function are discussed. Topics discussed in detail include the use of ^{131}I-oleic and ^{131}I-triolein in studies of fat absorption or digestion; the use of ^{131}I-rose bengal in liver function tests; the use of ^{64}Cu in studies of Cu metabolism; the use of ^{51}Cr-erythrocytes in the assessment of gastrointestinal tract blood loss; the use of the selective uptake of ^{32}P and internal counting, ^{32}P in vivo autoradiography, or Na ^{131}I and external counting for the early diagnosis of gastric carcinoma; the use of ^{131}I-serum albumin in studies of protein absorption and digestion; the use of ^{51}Cr in assessing gastrointestinal transit time; and the use of ^{131}I-polyvinylpyrrolidone in studies of protein loss into the gastrointestinal tract. (97 references.) (C.H.)

15320 KIDNEY, LIVER, AND CIRCULATION STUDIES BY RADIOACTIVE ISOTOPES. Prentiss M. Dettman. p.529-48 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

Radioisotope techniques for use in studies of kidney function, liver function, and blood circulation are discussed. Topics discussed in detail include the use of ^{131}I-Hippuran and ^{203}Hg-Neohydrin for renograms for use in the diagnosis of kidney diseases; the use of ^{131}I-rose bengal, ^{131}I-human serum albumin, colloidal ^{198}Au, and ^{131}I-triolein in the diagnosis of liver diseases; and blood circulation studies using ^{32}P-erythrocytes, ^{51}Cr-erythrocytes, or ^{131}I-human serum albumin as tracers to measure cardiac output by the indicator-dilution method; the use of ^{42}K or ^{86}Rb uptake by the myocardium as a measure of coronary blood flow; the use of ^{131}I-human serum albumin, ^{131}I-renograph, ^{131}I-methyl or ethyl iodide, and radioactive gases such as ^{85}Kr for the study of circulatory shunts; the use of ^{24}Na and ^{131}I-human serum albumin in studies of circulation time; and the use of colloidal ^{198}Au in studies of circulation time; and the use of colloidal ^{198}Au in studies of blood circulation in the liver and ^{85}Kr or ^{79}Kr for cerebral circulation studies. (95 references.) (C.H.)

15321 RADIOIODINE THERAPY. Ronald R. Lund. p.549-71 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The ability of thyroid tissue to concentrate and retain radioactive iodine makes these isotopes useful in treating any condition that will benefit by the complete or partial destruction of functioning thyroid tissue. Such conditions include hyperthyroidism, certain refractory cardiac and pulmonary diseases, and thyroid carcinoma. Applications

of ^{131}I in the treatment of hyperthyroidism, in euthyroid patients with cardiac disease, and in thyroid cancer are discussed in detail. (93 references.) (C.H.)

15322 MEDICAL APPLICATIONS OF RADIOACTIVE PHOSPHORUS. William S. Maxfield. p.572-98 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The metabolism of P and factors affecting the uptake and retention of ^{32}P by neoplastic tissues are discussed. Procedures are given for calculations of the radiation dose from ^{32}P in tissues. Tracer applications in metabolic research and in the diagnosis and localization of tumors of the breast, brain, eye, skin, gonads, bone, and thyroid gland are described. Therapeutic applications discussed include the treatment of polycythemia vera, lymphoma, chronic leukemia, hemorrhagic thrombocythemia, primary tumors of bone, bone metastasis, primary tumors of brain, breast cancer, lung carcinoma, superficial skin carcinoma and keratosis, mycosis fungoides, multiple myeloma, and malignant effusions. (170 references.) (C.H.)

15323 RADIOISOTOPE THERAPY UTILIZING RADIOCOLLOIDS. E. Richard King. p.599-614 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The use of intracavitary radioactive colloids for the treatment of effusions of the chest, abdomen, or pericardial sac due to the spread of malignancy is discussed. It is pointed out that the exact effect of radioactive colloidal compounds in the depression of fluid formation is not known. Several theories are discussed. The radioactive colloids most commonly used are colloidal ^{198}Au and ^{32}P-chromic phosphate, although colloidal $^{90}YCl_3$ is sometimes used. Techniques for the preparation and intracavitary administration of radioactive colloids are described. Clinical results are summarized for a number of cases. The use of interstitial colloidal ^{198}Au in the treatment of carcinoma of the prostate is also described. (31 references.) (C.H.)

15324 RADIOISOTOPE TELETHERAPY UNITS. John R. Hartman. p.651-64 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The development of radioisotope radiotherapy units is reviewed. Design features of teletherapy units are described and advantages over x ray sources are discussed. Cobalt-60 and ^{137}Cs teletherapy machines are available commercially for γ therapy and ^{192}Ir teletherapy units have been built. Strontium-90 β teletherapy units have also been constructed. It is concluded that the popularity of telegammatherapy units will continue to increase with ^{60}Co and ^{137}Cs units dominating the field. (24 references.) (C.H.)

15325 THE USE OF ARTIFICIAL RADIOISOTOPES IN BRACHYTHERAPY. William Bruce Lundeen. p.665-78 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The use of radioisotopes in interstitial and intracavitary applicators is discussed. It is pointed out that the availability of high neutron fluxes in controlled, critical, self-sustained chain reactions has provided a large number of relatively short-lived, inexpensive, and versatile radioisotopes for use in radiotherapy. Broad energy and activity spectra are available for use in radioapplicators and the limitations imposed by pathological anatomy on rigid linear sources can in some instances be obviated by flexible wire or plastic applicators. After loading techniques of insertion are described that greatly reduce operator exposure. The uses of ^{60}Co, ^{198}Au, ^{192}Ir, ^{51}Cr, and ^{90}Y in brachytherapy are discussed in detail. (22 references.) (C.H.)

15326 BEENMERGDOSIS TENGEVOLGE VAN DE RONTGENDIAGNOSTIEK. (Marrow Dose in Consequence of X-Ray Diagnosis). Jan Weber. Thesis, Leiden, Rijksuniversiteit, 1964. 115p.

An analysis was made of the various factors that determine the bone marrow doses of the Dutch population resulting from diagnostic radiology. The results of dosimetric experiments were combined with information on the frequency of roentgendiagnostic examinations in order to obtain an estimation of the per capita annual mean bone marrow dose. Measurements were performed in a phantom, which was subjected to standard exposures used in radiology. Construction of the phantom is described. The results showed that the largest contribution to the dose is due to chest examination (43%); in combination the next 5 contributors (lumbo sacral region, lumbar spine, urography, colon, and upper gastrointestinal tract) yield 42% of the dose. An estimation of the possible leukemia induction was also made and the results are discussed. Data are tabulated. 119 references are included. (P.C.H.)

15327 RADIATION AND RADIOMIMETIC CHEMICALS: COMPARATIVE PHYSIOLOGICAL EFFECTS. Leslie Alderman Elson. Washington, D. C., Butterworth, 1963. 124p. $3.50.

Radiotherapy and antineoplastic agents are discussed in this cancer monograph series publication. (BBB)

15328 SPECTRA OF THE MULTIPLE-SCATTERED RADIATION IN A MEDIUM IRRADIATED WITH COBALT 60 γ RAYS. R. M. Derbowka and D. V. Cormack (Univ. of Saskatchewan, Saskatoon and Saskatoon Cancer Clinic). 24p. (CONF-640611-1)

From Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Can.

A scintillation spectrometer with a 2 by 2 in. NaI(Tl) crystal was used to measure the spectrum of the scattered radiation in a hard-board phantom irradiated with the beam from a ^{60}Co teletherapy unit. Spectral measurements were made of the radiation traveling at various angles to the primary beam at depths of 2, 5, 10 and 15 cm and for beam areas of 25 and 100 cm^2. At each angle the spectrum of once-scattered photons from a thin scatterer was also measured. These spectra of once-scattered radiation were fitted to the peaks of the spectra from the phantom and were subtracted to obtain the spectra of multiple-scattered photons. The resulting multiple-scatter spectra were corrected for distortions in the crystal and were integrated with respect to the scattering angle. These integrated spectra were then compared with spectra derived from the calculations of Bruce and Johns. Although the measured and calculated curves show the same general features, there appear to be real differences in the width and position of the low-energy peak of the spectrum. These differences are most pronounced at the smaller depths. (auth)

15329 RADIOISOTOPE SCANNING TECHNIQUES—COLLIMATOR EVALUATION. W. Hnidek, T. D. Cradduck, and S. O. Fedoruk (Saskatoon Cancer Clinic and Univ. of Saskatchewan, Saskatoon). 8p. (CONF-640611-7)

From Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Can.

Three possible collimators for liver scanning with the whole-body scanner at the University of Saskatchewan were evaluated using a model liver loaded with ^{131}I in H_2O and containing two lucite spheres representing lesions. The collimators were made of Pb six inches in thickness with either 19 or 37 holes in different arrangements. The 19-hole collimator was selected for routine kidney and liver scans. (D.C.W.)

CHEMISTRY

General

Refer also to abstract 14947.

15330 (ANL-6900) CHEMICAL ENGINEERING DIVISION SEMIANNUAL REPORT, JANUARY–JUNE 1964. (Argonne National Lab., Ill.). Aug. 1964. Contract W-31-109-eng-38. 340p. Dep.; $7.00(cy), 6(mn) CFSTI.

Research and development in chemical engineering is reported in 8 sections. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 15408, 15662, 15663, 16059, 16445, 16836, 16837, and 17174.

15331 (BNL-841(p.18-42)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. O. E. Dwyer and R. H. Wiswall (Brookhaven National Lab., Upton, N. Y.).

In the radiation chemistry of fluorocarbons, data are now available which permit comparison of three types of "aromatic" structures (those of benzene, biphenyl, and naphthalene) with the corresponding saturated "alicyclic" fluorocarbons. For each pair, the difference in radiation stability was slight. All the compounds showed good but not outstanding performance. The reaction between Xe and F_2 was found to be induced by a beam of 10-Mev protons at a good rate although with a lower radiation yield than in electron or gamma radiation. A mixture of XeF_2 and XeF_4 was formed. Galvanic cells containing ceramic membranes permeable to a particular cation continued to be a useful source of thermodynamic data on salt mixtures. The systems $LiCl-PbCl_2$, $LiCl-CaCl_2$, and $KCl-CaCl_2$ were so investigated. Cells containing solid electrolytes were used to obtain the free energy of formation of $CaCl_2$, $NiCl_2$, and CaF_2. An absorption spectrum was obtained on the liquid subhalide system, $Cd-CdCl_2$. In the determination of the sublimation temperature of graphite as a function of C/H ratio, the use of a vapor phase chromatograph made it possible to analyze the product gas in equilibrium with graphite. In the absence of Ar, starting either with $CH_4 + H_2$ or $C_2H_2 + H_2$, equilibrium appears to exist at the graphite filament even though the product gas is essentially $H_2 + CH_4$. Conversion of C_2H_2 to CH_4 appears to occur in the vapor phase rather than at the graphite surface. At 0.1 atm, the experimental values of the sublimation temperature agree with theoretical calculations in the range 2400° to 2700°K. Using results obtained from the ^{85}Kr traced Kr surface area apparatus, equations were obtained for the total surface area of three nuclear-grade graphites which apply to samples of different size and shape. These equations are based on data from particle sizes varying from $\frac{1}{8}$-in. cubes to 200-mesh particles. The results are: TSX, $\sigma_T = 0.43 + 60.4\sigma_g$; AGOT, $\sigma_T = 0.39 + 60.6\sigma_g$; ZTA, $\sigma_T = 0.03 + 139.7\sigma_g$; where σ_T = total surface area, m^2/g, and σ_g = external geometrical surface area, m^2/g. Engineering-scale tests of the dissolution of U-Zr fuel in the 95°C Nitrofluor azeotrope, of approximate composition $NOF \cdot 3HF$ plus a trace of N_2O_3, are about ready to begin. Only an air scrubber, required by safety considerations in the event of a spill, remains to be completed. Solvent received from Ozark-Mahoning has proved satisfactory. Further detailed studies were made on the kinetics of dissolution of U-Zr, Al, and U-Al in the 95° solvent and also in the azeotrope of N_2O_3 and HF which boils at 68°. Rates in general fell off quite fast as the reactions proceeded. This slowing-down was less, the greater the original ratio of solvent to sample. The rate behavior of a particular system is conveniently summarized by giving the solvent/metal ratio required for complete dissolution of a sample in a given time. Thus, a satisfactory batch of 95° solvent will, at a solvent-to-metal weight ratio of 10, dissolve a sample in 3 hr at 60°C. To achieve the same result with Al, a temperature of 121° was required. The 68° azeotrope acted slower on Al than the 95° material. Its rate was somewhat improved by the addition of N_2O_3, to get a composition N_2O_3-8.3HF. Uranium was easily recovered from the fluoride mixture resulting from the dissolution of U-Al fuel in the 95° solvent. A single BrF_3 treatment results in the volatilization of >99% of the U. Fractional distillation of mixtures of N_2O_4 and HF, and spectrophotometric examination of the vapors, showed that reactions which had been previously postulated to account for the corrosiveness of these mixtures do indeed take place. One such reaction is $N_2O_4 + HF \rightarrow HNO_3 + NOF$; and evidence for the species on the right was in fact found. From 25% N_2O_4-75% HF there was obtained, on distillation, appreciable quantities of a 95° fraction identical with that prepared by the reaction of NOCl with HF. Precise kinetic studies on the corrosion of Ni by liquid N_2O_4-HF mixtures at 150°C showed, surprisingly, a faster reaction than that of Monel, though its rate, 3 mils/year, was still quite acceptable. The vapor-phase corrosion of Ni and Monel in N_2O_4-HF systems to which small amounts of water vapor had been added proceeded at a measurable but not excessive rate. The protective character of the films was evidently lessened by the presence of the water vapor or its reaction products. Fluoride-promoted oxidation in inert fluidized beds is being studied as a means of decladding Yankee fuel rods (type 348 SS-clad UO_2). Difficulty has thus far been encountered in reacting all the cladding material and only 80 to 90% of the UO_2 has been removed from the cladding in 14-hr oxidation periods. In connection with the study on the methods of disposal of high-level radioactive wastes, several extended phosphate glass pilot plant runs provided engineering data useful in future plant design. Bench-scale equipment planned for use in the hot cell at Hanford with full level feed has been successfully operated at BNL. Studies are in progress to investigate the chemical state of I_2 released from reactor fuels into steam. In one experiment with UO_2 fuel material, >80% of the I_2 released at 1200°C was elemental. This is in marked contrast to earlier studies with metallic U heated in steam where 80 to 90% of the I_2 was collected in the reduced form in aqueous solution. This experiment then, indicates the importance of H_2-I_2 reactions during I_2 release from metal fuel elements in the presence of water. In experiments conducted at 1200°C in a He atmosphere, I_2 is released from metallic U in combined form, apparently as a uranium iodide. Sufficient quantities of U were detected in the I_2 collection regions to account for this. An experiment at 1800°C has again shown that this compound is partly dissociated to elemental I_2 at this higher temperature, which is consistent with theoretical predictions. The release of I_2 from a hypostoichiometric UC sphere, irradiated to 2.6×10^{18} nvt, was studied at isothermal steps over the temperature range 1330° to 1680°C. Preliminary diffusion coefficients ranged from 10^{-12} to 10^{-10} cm^2/sec, respectively. Initial studies of the spectra of U fission release products were concentrated on UI_3. Attempts to obtain the emission spectrum of this molecule via microwave excited electrodeless discharges in low pressure He or Ar atmospheres resulted only in the production of atomic U spectra. Further experimental work was carried out on the determination of the free energy of formation of UI_3 at 350°C by emf measurements. In the studies of liquid-metal heat transfer, further data were obtained for the case of in-line turbulent flow of Hg through rod bundles. They confirmed both theoretical predictions made earlier and previous experimental results at BNL. Preliminary results were obtained for the case of heat transfer to Hg flowing through an annulus, with an adiabatic outer wall. The heat transfer coefficients were in fair agreement with theoretical predictions, but the eddy diffusivity profiles for both heat and momentum transfer showed considerable variation from run to run. The construction of the loop for studying heat transfer to boiling K is about 75% complete. Early results show that coefficients, for the case of heat transfer to liquid metals flowing in annuli, are greatly dependent on degree of eccentricity. Sharp reduc-

tions are brought about with only slight degrees of eccentricity. Equations were developed for the case of heat transfer to or from liquid metals flowing past single spheres for several different boundary conditions. (J.R.D.)

15332 (BNL-841(p.52-62)) HOT LABORATORY DIVISION. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

The anomalous behavior of the adsorption and elution of ^{132}I and ^{132}Te from alumina is due to the difference in behavior of Te(IV) and Te(VI) on alumina and to more or less rapid oxidation of Te(IV) to Te(VI) depending on factors such as pH and concentration but probably not on radiation. The feasibility of making a generator from which the shorter-lived ground states of ^{131}Te, ^{129}Te, and ^{127}Te can be milked from their respective longer-lived metastable isomeric parents was positively demonstrated. A satisfactory technique for making Ca targets for cyclotron bombardment was found, and the chemistry was worked out for isolating the Ti, Sc, and Ca fractions following alpha bombardment of such targets; a preliminary search for hitherto undiscovered ^{42}Ti was unsuccessful. Development of a method for preparing carrier-free ^{132}Cs was resumed. The $^{40}Ar(\alpha,2p)^{42}Ar$ and $^{40}Ar(t,p)^{42}Ar$ reactions were detected, the latter induced by tritons from the $^{6}Li(n,t)^{4}He$ reaction in the BGRR. Construction of an extended table of nuclidic masses continues. The excitation functions for the Mg-t reactions were corrected for recoil of product from one foil into the adjacent foil. Yields of ^{87m}Sr are slightly lower in all-glass generators than in all-plastic generators. Useful extraction methods were found for separating ^{68}Ga from the EDTA complex furnished by a ^{68}Ga generator. Other subjects on which work was performed include the preparation of ^{52}Fe and the (t,n) reactions on Fe, Ni, and ^{30}Si. The proximity of the half-wave potentials of Pb and Cd at the dropping Hg electrode in molten $LiNO_3$-KNO_3 eutectic was shown to be due to a specific effect of the molten nitrate environment on one or both of the solute ions. Observation and measurement of a second-order disproportionation of U(V) in 1 M acetate were made chronopotentiometrically. Plaselenol reduced with Na yields (initially) only one product, and that has the characteristics of a free radical. The synergistic effects between TTA and TnOA in the extraction of Am are being investigated. Methods were developed for determining ^{228}Th, ^{230}Th, and ^{232}Th in Thorotrast; oxygen in Na; Zr, Nb, and Mg in Hg; and ratios of the five possible methane isomers formed by replacing hydrogen with deuterium. Isotope shipments were lower than normal averaged but the rate is showing a decided rise. The development of a method for incorporating ^{99m}Tc in colloidal particles of ~100-mμ size compatible with body fluids has permitted outstanding improvement in autoradiography of organs such as the liver. (N.W.R.)

Analytical Procedures

15333 (AE-168) A FAST RADIOCHEMICAL METHOD FOR THE DETERMINATION OF SOME ESSENTIAL TRACE ELEMENTS IN BIOLOGY AND MEDICINE. K. Samshal (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1964. 12p. Dep.(mn).

A method was developed for the determination with neutron-activation analysis of the following trace elements in soft biological tissues: Br, Ca, Cl, Cu, K, Mg, Mn, Mo, Na, P, Sr, and Zn. The method consists in performing a short-term irradiation of the samples with a high thermal neutron flux, followed by fast chemical separations and gamma-spectrometric measurements. The chemical separations and the measurements of short-lived nuclides from a run are finished within 70 min after the end of irradiation. (auth)

15334 (AE-169) CONCENTRATION OF 17 ELEMENTS IN SUBCELLULAR FRACTIONS OF BEEF HEART TISSUE DETERMINED BY NEUTRON ACTIVATION ANALYSIS. P. O. Wester (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1964. 29p. Dep.(mn)

Subcellular fractions of beef heart tissue are investigated, by means of neutron activation analysis, with respect to their concentration of 17 different elements. A recently developed ion-exchange technique combined with gamma spectrometry was used. The homogeneity of the subcellular fractions was examined electronmicroscopically. The following elements are determined: As, Ba, Br, Ca, Co, Cs, Cu, Fe, Hg, La, Mo, P, Rb, Se, Sm, W and Zn. The determination of Ag, Au, Cd, Ce, Cr, Sb and Sc was omitted, in view of contamination. Reproducible and characteristic patterns of distribution were obtained for all elements studied. (auth)

15335 (AE-172) RECOIL REACTIONS IN NEUTRON-ACTIVATION ANALYSIS. I. THE SZILARD-CHALMERS EFFECT APPLIED IN THE ANALYSIS OF BIOLOGICAL SAMPLES. II. TRANSFER OF ACTIVITIES FROM CONTAINER MATERIAL TO SAMPLE. Dag Brune (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1965. 27p. Dep. (mn).

The application of the Szilard-Chalmers effect in the separation of activities from neutron-irradiated biological material was studied. The nuclides ^{76}As, ^{198}Au, ^{82}Br, ^{47}Ca, ^{115}Cd, ^{38}Cl, ^{60}Co, ^{51}Cr, ^{134}Cs, ^{64}Cu, ^{59}Fe, ^{27}Mg, ^{99}Mo, ^{24}Na, ^{32}P, ^{86}Rb, ^{75}Se, and ^{65}Zn were extracted from either liver tissue, whole blood, or muscle tissue. The extractions were made in water, 0.1 N HCl, 1 N HCl, or conc. HCl respectively. The nuclides belonging to the alkali metals together with ^{82}Br and ^{38}Cl, were found present in the water and hydrochloric extracts to 96 per cent or more. In the conc. HCl extracts, the greater part of the nuclides were recovered to 90 percent or more. The enrichment of the different nuclides obtained in the Szilard-Chalmers process was investigated as follows. After extraction of the nuclides from the irradiated material the solution obtained was divided into two parts, one of which was reactivated. The specific activities of the nuclides in the two solutions were then compared, thus giving the enrichment factor. In one case, the residue of organic material after extraction was reactivated and the activity compared to the initial one. The effect of dilution together with the application of short irradiation periods favoring higher yield was investigated in the separation of ^{59}Fe from whole blood samples irradiated in frozen conditions. An estimation was made of the amounts of the activities originating from polyethylene and quartz containers transferred to container surface due to the recoil effect in the thermal neutron-capture process, thus causing contamination of the sample. The universal range-energy relationship given by Lindhard and Scharff was applied in these calculations. As regards containers with impurities in the ppm region, the amounts of activities transferred owing to this effect were found to be quite negligible. However, when the containers were rinsed with hydrochloric acid, activities were found to be extractable from a depth of the order of magnitude 10^{-3} and 10^{-4} cm in the polyethylene and the quartz materials respectively, which in some cases necessitates corrections. (auth)

15336 (AEET/Spec./3) SPECTROGRAPHIC ANALYSIS OF COBALT OXIDE (Co_3O_4) FOR TRACE IMPURITIES. P. C. Ghosh and M. V. Joshi (Atomic Energy Establishment, Trombay, India). 1964. 10p. Dep.(mn).

A spectrographic method is given for the determination of copper, iron, nickel, chromium, manganese, magnesium, and aluminium in cobalt oxide (Co_3O_4). Graphite powder is used as a buffer. It is mixed with the sample in the ratio of 1 : 1 by weight and excited in a d-c arc in an atmosphere of oxygen. The method was standardized and working curves drawn for impurity range of 2 to 250 ppm. The mean standard deviation of the method varies from 9% to 18% for different elements. (auth)

15337 (AEET/Spec./4) SPECTROCHEMICAL DETERMINATION OF BORON IN GRAPHITE. A. P. D'Silva, T. R. Saranathan, and L. C. Chandola (Atomic Energy Establishment, Trombay (India)). 1964. 12p. Dep.(mn).

A spectrochemical method was worked out for the determination of boron in graphite with a detection limit of 0.05 ppm. The graphite sample is ashed in the presence of

a mixture of calcium oxide and calcium sucrate at 800°C in oxygen. 50 mg pellets of the resulting calcium oxide are arced in an atmosphere of argon. The standard line pair B 2497.7/Au 2428.0 gave a precision of 6.5%. The effect of large amounts of iron, silicon, chlorine, and fluorine was investigated. (auth)

15338 (AEET/Spec./6) SPECTROGRAPHIC DETERMINATION OF Ce, Pr AND Nd IN La_2O_3. S. V. Grampurohit, P. Sreerama Murthy, and T. R. Saranathan (Atomic Energy Establishment, Trombay (India)). 1964. 10p. Dep.(mn).

An emission spectrographic method was developed to determine Ce, Pr, and Nd in pure lanthanum oxide. The concentration ranges covered are: Ce 0.01 to 0.1%, Pr 0.0025 to 0.1%, and Nd 0.005 to 0.1%. 15 mg of the sample are taken in a $\frac{1}{4}$-in. spec-tech graphite anode and arced against a $\frac{3}{16}$-in. spec-tech graphite cathode at a current of 10 amps. The spectra are photographed on a 3.4 meter Ebert spectrograph using a 30,000 lines/inch plane grating in the first order. The analytical lines of Ce, Pr, and Nd are 4222.60, 4225.33, and 4303.57 Å respectively. The lanthanum line at 4221.23 Å is used as the internal standard line. (auth)

15339 (AEET/Spec./7) SPECTROGRAPHIC DETERMINATION OF La, Pr, Nd AND Sm IN CeO_2. P. Sreerama Murty and I. J. Machade (Atomic Energy Establishment, Trombay (India)). 1964. 13p. Dep.(mn).

An emission spectrographic method employing d-c arc excitation was developed to determine La, Pr, Nd, and Sm in pure cerium oxide. The concentration ranges covered are: La 0.01 to 0.5%, Pr 0.05 to 0.5%, Nd 0.01 to 0.5%, and Sm 0.01 to 0.5%. The sample is mixed with graphite powder in the ratio 1:1 by weight and 15 mg of the mixture are taken in a $\frac{1}{4}$-in. graphite anode and arced at a current of 10 amps. The spectra are photographed on a 3.4 meter Ebert Spectrograph using the 30,000 lines/inch plane grating in the first order. (auth)

15340 (APDA-166) DETERMINATION OF CARBONATE CARBON IN SODIUM METAL. D. F. Boltz and S. A. Meacham (Atomic Power Development Associates, Inc., Detroit, Mich.). Jan. 15, 1965. Contract AT(11-1)-865. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An analytical method was developed for the determination of carbonate carbon in sodium metal. This method is based on the carefully controlled dissolution of the sodium sample in water, the evolution and collection of carbon dioxide, and the measurement of the carbon dioxide by gas chromatography. An investigation of the relative merits of water-dissolution and alcohol-dissolution techniques resulted in the selection of water as the solvent. An indication of the precision of the method for the determination of carbonate carbon in sodium metal was obtained from the results of replicate determinations on three different samples of sodium metal. Standard deviations of 0.2 to 0.26 ppm and relative standard deviations of 4 to 7% were obtained using the water-dissolution technique. (auth)

15341 (COO-1148-93) EFFECT OF DIRECTION OF POLARIZATION ON CURRENT-POTENTIAL CURVES AT SOLID ELECTRODES. Laura Chuang and Philip J. Elving (Michigan Univ., Ann Arbor). Jan. 20, 1965. Contract AT(11-1)-1148. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Reverse polarization, i.e., variation of the potential from a value at which an electrode reaction normally occurs to one at which the reaction normally ceases, at a stationary electrode often allows observation of the voltammetric wave due to the electrolysis of the product produced in the original electrode reaction. In the case of a reversible redox couple, reverse polarization for either species results in a single wave with both cathodic and anodic components; for an irreversible redox couple, the wave due to electrolysis of the reaction product is observed on reverse polarization. The technique of reverse polarization can be used to identify electrode reaction products and to obtain potential data for unstable species. The method has been applied to two reversible systems (ferri-ferrocyanide and nitrosobenzene-phenylhydroxylamine) and two irreversible systems (azoxybenzene-hydrazobenzene and azobenzene-hydrazobenzene). (auth)

15342 (DCI-52) DETERMINATION OF WATER IN ORGANIC COOLANT. G. R. Matteau and R. W. Ashley (Atomic Energy of Canada Ltd., Chalk River, Ontario). Jan. 1965. 17p. (AECL-2164). Dep.; $0.50(AECL).

A method for the determination of water in organic coolant is described. Water is extracted with chloroform by an azeotropic distillation and titrated using a Beckman KF-3 Aquameter. The precision and accuracy of the method are ± 1% (relative) for 1.5 mg or more of water. (auth)

15343 (DPSPU-63-30-37) ASSESSMENT OF TRITIUM IN PRODUCTION WORKERS. F. E. Butler (Du Pont de Nemours (E. I.) & Co., Aiken, S. C.). Savannah River Plant. Mar. 1964. Contract AT(07-2)-1. 17p. (CONF-448-35) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, Ger., May 1964.

The tritium bio-assay program at the Savannah River Plant is geared for rapid urinalysis of large numbers of samples. More than 300,000 urine samples have been analyzed in the past ten years. A liquid scintillation counting procedure currently used for analysis of urine samples is described. Untreated samples containing as little as 1 μc of tritium per liter can be assayed in one minute. The detection limit for distilled urine is 5×10^{-4} μc of tritium per liter. Automation of equipment, optimum scintillation mixture and sample volumes, selection of reagents and counting containers, and elimination of interfering radionuclides are discussed. Empirical studies of biological half-life are summarized. In 310 cases where the initial tritium concentrations in urine ranged from 20 to 118 μc per liter, the average biological half-life was 9.5 days. The half-life varied inversely with ambient temperature and age of employees. (auth)

15344 (EUR-2207.i) DETERMINAZIONE DELL'OSSIDO DI ALLUMINIO NELLE POLVERI E NEI PRODOTTI FINITI SAP—ESAME CRITICO DEI DIVERSI METODI ANALITICI. (Determination of Aluminum Oxide in SAP Powders and Sintered Products—Critical Examination of Other Analytical Methods). G. Serrini, J. Collin, and W. Leyendecker (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 1965. 22p. Dep.(mn).

The determination of aluminum oxide in SAP powder and sintered products is described. The method employed is the separation of aluminum metal by gaseous hydrochloric acid. Some modifications applied to the original method have improved and hastened the determination of these samples. The coefficient of variation of the method is ±1.5% for sintered products and ±2-3% for powders. A critical examination of the other methods is also reported. (auth)

15345 (IDO-11401(p.395-465)) ANALYTICAL METHODS FOR ORGANIC REACTOR COOLANT. Robert C. Shepard and Robert T. Keen (Atomics International, Canoga Park, Calif.).

A review is presented of analytical methods and techniques used to study the stability, properties, and film-forming potential of organic coolants. Their scope, limitations, and problem areas are discussed. (D.L.C.)

15346 (IS-1105) ANALYSIS OF A DAMASCUS STEEL BY NEUTRON AND GAMMA ACTIVATION. A. F. Voigt and A. Abu-Samra (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 25, 1965. Contract W-7405-eng-82. 12p. (CONF-650405-1) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For Presentation at International Conference on Modern Trends in Activation Analysis, College Station, Tex.

A sword obtained in Damascus and estimated to be about 400 years old was analyzed for trace metals and carbon by a combination of neutron and photon activation. Methods were developed for each quantitative analysis after qualitative activation analysis demonstrated which elements were present and detectable. Manganese was determined by the use of 2.6-hr ^{56}Mn, counting the 845-kev gamma peak.

There were no interfering activities and chemical separation was not necessary. By comparison with standards the manganese content was found to be 710 ppm, with a precision of ±40 ppm. For arsenic, the 27-hour ^{76}As was used with a chemical separation involving the volatilization of $AsCl_3$ and precipitation of As_2S_3. The 550-kev peak in the ^{76}As spectrum was counted. The arsenic content was found to be 48 ± 10 ppm. Copper was determined with a chemical separation using α benzoinoxime and counting the annihilation peaks at 511 and 1022 kev with a well type crystal. Results using the two peaks were identical giving 340 ± 40 ppm as the copper content. Carbon was determined by the use of 20.5 min ^{11}C produced by bremsstrahlung from a 70-Mev electron synchrotron and detected by the annihilation radiation. The simultaneous production of 20 min ^{52m}Mn by the (γ,pn) reaction ^{54}Fe (5.8% abundant) presented a serious problem since the half-life of ^{11}C did not permit chemical separation and ^{11}C and ^{52m}Mn are both positron emitters. Correction for ^{52m}Mn was possible since it also emits a 1435-kev γ ray while the ^{11}C positron is not accompanied by any gamma radiation. By the synchrotron irradiation of electrolytic iron with essentially zero carbon content, ^{52m}Mn was produced free of any ^{11}C and its spectrum was recorded. The ratio of the counting rate of 511 kev to that at 1435 due solely to ^{52m}Mn was obtained by correcting these rates for the contribution by ^{56}Mn, produced by the (γ,p) reaction on ^{57}Fe. Corrections based on this ratio and the ^{56}Mn produced were applied to the data from the irradiation of the steel, leaving just the ^{11}C contribution to the 511-kev peak. Comparison with graphite standards gave 1.11 ± 0.06% as the carbon content of the steel. (auth)

15347 (MLM-1163(p,J-1-14)) APPLICATION OF DIFFERENTIAL THERMAL ANALYSIS TO THE STUDY OF PHASE EQUILIBRIA. D. E. Etter (Mound Lab., Miamisburg, Ohio).

The thermocouples and circuits used in DTA are discussed. The DTA apparatus and furnace unit are described. DTA traces for pure Pu and Pu containing 240 ppm Fe are used to show how DTA can be used to study phase equilibria. Hypothetical binary phase diagrams are used to show the DTA traces that might be expected for various phase reactions. Examples of phase diagrams constructed using DTA are given for Cu–Pu and for Ce–Cu–Pu. (D.L.C.)

15348 (MLM-1163(p,K-1-10)) APPLICATION OF THE ELECTRON MICROPROBE X-RAY ANALYZER TO THE STUDY OF PHASE EQUILIBRIA. C. R. Hudgens (Mound Lab., Miamisburg, Ohio).

A description is given of an electron microprobe x-ray (EMX) analyzer and its components. Besides the generated x rays which are analyzed spectroscopically, electron backscattering also furnishes useful information. An electron beam scanning system increases the usefulness of the EMX analyzer. Applications of the EMX analyzer in qualitative and quantitative analysis are given, using Pu (Fe particles were found), Pu–Co–Ce (component distributions), Y–Pu, and U–C diffusion couple. (D.L.C.)

15349 (NLCO-929) THE APPLICABILITY OF THEORETICALLY CALCULATED INTENSITY CORRECTIONS IN MICROPROBE ANALYSIS. J. W. Colby (National Lead Co. of Ohio, Cincinnati). Sept. 24, 1964. Contract AT(30-1)-1156. 34p. (CONF-641018-3). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From the Electrochemical Society 126th Meeting, Washington, D. C.

Alloys having a wide variation in chemical composition have been analyzed in the microprobe. The results after applying theoretically calculated intensity corrections generally agree quite well with wet chemical analysis. The correction procedures employed are discussed in detail as well as the choice of mass absorption coefficients, fluorescence yields, and absorption jump ratios. (auth)

15350 (RCC-M-177) THE ESTIMATION OF THE AMOUNT OF AMERICIUM-241 ON DUST SAMPLING FILTERS. A COMPARISON OF MEASUREMENTS BY α-COUNTING AND γ-SPECTROMETRY. D. A. Cook (Radiochemical Centre, United Kingdom Atomic Energy Authority, Amersham (England)). Jan. 1965. 7p. Dep.; $0.30(BIS), 1s. 9d.(HMSO).

Some measurements on a dust sampling filter containing americium-241 are described. The results given show that when calculating the amount of americium-241 on glass fiber filter papers from the α-counting rate, the inclusion of a factor to allow for α-particle absorption may overestimate the activity. (auth)

15351 (SC-DC-64-1829) EVALUATION OF SOLVENT EXPOSURE BY BREATH ANALYSIS. Lial W. Brewer (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract [AT(29-1)-789]. 5p. (CONF-808-2) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Industrial Hygiene Assn. Rocky Mountain Section Meeting, Colorado Springs, Colo., Oct. 1964.

A simple and convenient method is described for the identification and quantitative determination of exposure to halogenated hydrocarbons by the analysis of expired breath. (C.H.)

15352 (CEA-tr-A-1597) CONTRIBUTION A LA MICROANALYSE DE L'IODE-131 RADIOACTIF. ADSORPTION SUR L'AMBERLITE IRA-400. (Contribution to the Microanalysis of Radioactive Iodine-131. Adsorption on Amberlite IRA-400). M. Lesigang and H. Hecht. Translated into French from Mikrochim. Acta, Nos. 1/2, 326-31(1962). 9p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The enrichment of the iodide ion on the strongly basic anion exchanger Amberlite IRA-400 (Cl^-) was studied. A possibility for the fast elution of the iodide ion on a very small volume with a solution of 4M ammonium chloride, by using a Kipp exchange column, was proposed. This makes possible a quantitative determination, by means of a liquid counter tube, of the radioactive iodide-131. (tr-auth)

15353 (CEA-tr-A-1706) DETERMINATION DE L'IODE RADIOACTIF. (Determination of Radioactive Iodine). L. Hainberger and S. Sanchez. Translated into French from Mikrochim. Acta, No. 1, 87-91(1962). 8p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

Two methods in which radioactive iodine, distributed uniformly in samples of standard dimensions, can be measured with a Geiger counter are described. In one method, the carrier-free radioactive iodine is deposited on a filter paper impregnated with silver iodide by heterogeneous isotopic exchange. In the second method, a mixture of active and inactive iodine is precipitated on filter paper impregnated with silver oxalate. A sample of standard size is cut out in the silver iodide surface and measured with the counter. The total activity is deduced from the ratio of the surfaces. The total quantity of iodine can be calculated. (tr-auth)

15354 LIQUID SCINTILLATION COUNTING OF THE POTASSIUM GLUCONATE DERIVATIVE OF BLOOD GLUCOSE. Calvin L. Long and John W. Geiger (Peter Bend Brigham Hospital, Boston). Anal. Biochem., 10: 253-9 (Feb. 1965).

Conditions for the radioactive assay of the water-soluble potassium gluconate derivative of blood glucose by liquid scintillation are described. This method is of value when the counting of individual carbon atoms of the glucose molecule is not desired. The decline of blood glucose specific activity was determined in a normal subject. (auth)

15355 APPLICATION OF LIQUID SCINTILLATION COUNTING TO I^{131} MEASUREMENT. Herbert F. Polesky and David Seligson (Yale Univ., New Haven). Anal. Biochem., 10: 347-50(Feb. 1965).

The feasibility, reliability, and limitations of counting the beta emissions of ^{131}I by liquid scintillation techniques were investigated. The results showed that standard liquid scintillation techniques are feasible for counting the beta emission of ^{131}I and are up to seven times more efficient than a standard gamma detection system. The increased efficiency obtained and high degree of automation available in liquid scintillation systems minimize the restrictions of the technique. (P.C.H.)

15356 CORRECTION FOR QUENCHING OF SAMPLES FROM AN OXYGEN FLASK COMBUSTION METHOD FOR TRITIUM ANALYSIS. Billy Baggett, Thomas L. Presson, Jack B. Presson, and James C. Coffey (Univ. of North Carolina, Chapel Hill). Anal. Biochem., 10: 367-70(Feb. 1965).

Modifications were made in quenching of samples from an oxygen flask combustion method for tritium analysis. Diotol containing 3% (v/v) water is used as the scintillation mixture. Immediately after the aliquots for counting are pipetted into vials, a stream of compressed air is bubbled through each sample at a rate of about 80 ml/min for 2 min. The air is filtered through glass wool and bubbled through water at 0°C, then through the samples by means of disposable pipets. Samples are recounted after the addition of an internal standard of tritiated palmitic acid in toluene. Correction of the counts by the addition of internal standard improved the recovery whether or not the samples were flushed. The flushing procedure further improved the recoveries. A combination of flushing and correction with internal standards gave recoveries of 94-97%. (P.C.H.)

15357 CONTROLLED-POTENTIAL COULOMETRIC TITRATION OF URANIUM(VI) IN AQUEOUS SOLUTIONS OF SODIUM FLUORIDE. W. R. Mountcastle, Jr., Louise B. Dunlap, and P. F. Thomason (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 336-40(Mar. 1965). (ORNL-P-521)

A method was developed for the controlled-potential coulometric titration of U(VI) in aqueous solutions of NaF. The method involves the coulometric reduction of U(VI) to U(IV) at −1.000 volt vs. S.C.E. in neutral or slightly acid 0.75 M NaF. The relative standard deviation was no greater than 0.5%; the relative error was +0.2 to +0.3% at the 6-mg level. Reasonable amounts of Cr(III), Cu(II), Mo(VI), and Zr(IV) did not interfere. Mole ratios at least as large as 1:1 for Fe(III) to U(VI) and 5:1 for Al(III) to U(VI) could be tolerated. The method was applied to a number of synthetic reactor-fuel dissolver solutions. (auth)

15358 DETERMINATION OF URANIUM AND AMERICIUM–CURIUM IN URINE BY LIQUID ION EXCHANGE. F. E. Butler (E. I. du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem., 37: 340-2(Mar. 1965).

Exchange of Th, Pa, U, Np, Pu, Am, Cm, and Cf from various concentrations of HNO_3 and HCl to liquid ion exchangers was determined. Both anion and cation exchangers were used; the former was triisooctylamine (TIOA), while the latter was di-2-ethylhexyl phosphoric acid (HDEHP). Tests with TIOA indicated preferential and rapid removal of U from other actinides, and in a mixture of Pu(III) and Np(IV), Np was extracted to TIOA. The reagent also separated ^{233}Pa from the parent ^{237}Np. HDEHP extracted more than 90% of all eight actinides from an acid solution adjusted in the pH range 4 to 5. At higher acidities, e.g., 4N HNO_3, all the actinides were extracted except Am, Cm, and Cf. Procedures were developed for determination of ^{235}U and ^{241}Am–^{244}Cm in urine. Tracer recoveries were greater than 90% and decontamination factors were sufficiently high for other actinides. Detection limits by direct alpha counting were 0.3 d.p.m. for 250-ml urine samples. Overall recoveries, through electrodeposition techniques, were 84 ± 10% for ^{235}U and 89 ± 6% for ^{241}Am. (auth)

15359 CONDENSATION PRESSURE ANALYZER AND ITS APPLICATION TO CONTINUOUS URANIUM HEXAFLUORIDE DETERMINATION. W. S. Pappas and C. W. Weber (Oak Ridge Gaseous Diffusion Plant, Tenn.). Anal. Chem., 37: 407-10(Mar. 1965). (TID-21115)

An automatic instrument was designed, which continuously determines the first condensable component in a gas system by measuring the dewpoint or condensation pressure at a fixed temperature. A pressure control valve actuated by a condensation detector maintains condensation pressure equilibrium. The instrument is applicable to corrosive systems and to mixtures of condensable gases; its pneumatic output signal is suitable, without modification, for automatic system control. One model provides a continuous and specific measurement of uranium hexafluoride in a plant stream with a relative standard deviation of ±0.12%. (auth)

15360 GAS ANALYSIS BY X-RAY FLUORESCENCE EMISSION SPECTROMETRY. C. R. Hudgens and George Pish (Monsanto Research Corp., Miamisburg, Ohio). Anal. Chem., 37: 414(Mar. 1965). (MLM-1230J)

An experiment, which demonstrated the feasibility of x-ray fluorescent gas analysis, is described. The analyses were performed on an x-ray generator and spectrometer, equipped with a reflecting quartz crystal cut on the 013 planes and a scintillation detector. Water cooling of the sample case was eliminated so that the case would heat sufficiently to completely volatilize the methyl iodide and ethyl bromide used in the analysis. Probable counting errors ranged from 2 to 5%. (M.C.G.)

15361 ANALYTICAL OXIDATION OF AMERICIUM WITH SODIUM PERXENATE. H. Perry Holcomb (E. I. du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem., 37: 415(Mar. 1965). (TID-21369)

The application of sodium perxenate, Na_4XeO_6, to the analytical oxidation of Am(III) to Am(VI) is reported. It was used as an oxidant in the separation of americium in tracer quantities from curium by means of calcium fluoride. Instead of using the CaF_2 column, Am(VI) could also be determined by alpha counting after removal of any remaining Am(III) by coprecipitation with lanthanum fluoride. (M.C.G.)

15362 SPECTROPHOTOMETRIC DETERMINATION OF IRON, NICKEL, COPPER, AND COBALT IN TUNGSTEN AND TUNGSTEN ALLOYS. George Norwitz and Herman Gordon (Frankford Arsenal, Philadelphia). Anal. Chem., 37: 417-19(Mar. 1965).

Iron, nickel, copper, and cobalt were determined rapidly in tungsten and tungsten alloys by spectrophotometric procedures by taking aliquots of a HCl-HNO_3 acid solution, which was buffered to a pH of approximately 6 by the addition of ammonium tartrate and sodium borate. Results are presented in tables. They compared favorably with results of classical methods. (M.C.G.)

15363 RAPID REMOVAL OF TRANSURANIUM ELEMENTS FROM AQUEOUS SOLUTIONS PRIOR TO THE DETERMINATION OF TOTAL LANTHANIDE FISSION PRODUCTS. Fletcher L. Moore and W. Thomas Mullins (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 419-20 (Mar. 1965). (ORNL-P-755)

An amine extraction method was developed for multiple batch actinide-lanthanide group separation for determination of total lanthanide fission products in solutions containing high levels of transuranium elements. Excess HCl had to be maintained in the aqueous phase to prevent high losses of lanthanide elements and precipitation of various metal ions. A mixed rare earth carrier containing lanthanum, cerium, europium, and yttrium was found to be quite satisfactory. The decontaminated aqueous solution could be analyzed for total lanthanide fission products by any one of several conventional procedures with the application of a yield correction. (M.C.G.)

15364 DETERMINATION OF AMERICIUM-243 BY SEPARATION AND COUNTING OF NEPTUNIUM-239 DAUGHTER. Cyril J. Banick (E. I. du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem., 37: 434-5(Mar. 1965).

A method was developed for determining low concentrations of ^{243}Am in actinide-fission product mixtures. The determination is based on the separation and counting of 56-hr ^{239}Np, the decay daughter of ^{243}Am. The values obtained by this method were 99.5% of the values obtained by mass spectrometry. The relative standard deviation of an individual determination was ±3.3%. (M.C.G.)

15365 SPECTROPHOTOMETRIC DETERMINATION OF CALCIUM IN URANIUM USING GLYOXAL BIS-(2-HYDROXYANIL). Alcidio Abrao (Instituto de Energia Atomica, Sao Paulo, Brazil). Anal. Chem., 37: 437-9 (Mar. 1965).

Nuclear-pure ammonium diuranate and uranium oxides were analyzed for their calcium content using glyoxal bis-

(2-hydroxyanil), after separation of the uranium with hydrogen peroxide precipitation, TBP extraction in nitric acid, or retention of the uranyl sulfate complex on an anionic ion exchange resin. (M.C.G.)

15366 CESIUM-137 IN RAINWATER. J. Benes (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Anal. Chim. Acta, 32: 85-8(Jan. 1965). (In German)

Sorption of the radionuclide on ion exchangers was investigated as a method for the concentration of Cs from any large mass of liquid radioactive precipitates. The optimum conditions for sorption of Cs on the cation exchanger and its elution were established. A suitable combination of this method with the coprecipitation method previously developed was found. A cesium yield of more than 95% was obtained. (J.S.R.)

15367 DIRECT-READING SPECTROCHEMICAL ANALYSIS OF SODIUM URANATE. M. Roca Adell and C. Capdevila Pérez (Junta de Energía Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 559-70(July-Aug. 1964). (In Spanish)

Application of the quantometer to analysis of sodium uranate is described. To determine boron, cadmium, phosphorus, and molybdenum content, the samples were mixed with graphite powder (1:30) and excited in a 10-amp d-c arc with 4 × 4.5 mm cup graphite rods, using silver as internal standard. A cup not as deep and a dilution factor of 90 were more suitable for calcium, copper, iron, silicon, and vanadium determination; cobalt and chromium were internal standards. The behavior of the different elements in every uranate was studied comparatively. (auth)

15368 DETERMINATION OF ACTIVE HYDROGEN BY ISOTOPIC EXCHANGE WITH DEUTERIUM OXIDE IN DIMETHYLFORMAMIDE. B. Casu and S. Sandroni (Istituto Guiliana Ronzoni, Milan). Ann. Chim. (Rome), 53: 1259-68(1963).

The sample is treated with an excess of a 5% solution of D_2O in dimethylformamide, and the active-H content is determined from the infrared absorption of the DHO formed by exchange measured at 2.86 μ. The influence of the concentration of the D_2O solution and background interferences was studied, and the method was applied to a wide range of compounds, including acids, alcohols, phenols, amines, amides, thiols, and malonates. (Analytical Abstr., 12: No. 1, Jan. 1965)

15369 INTERNAL LIQUID SCINTILLATION COUNTING FOR ABSOLUTE CALIBRATION OF RADIOISOTOPES. J. O. Burgman (Royal Inst. of Tech., Stockholm). Atompraxis, 11: 37-41(Jan. 1965).

The usefulness of internal sample liquid scintillation counting for absolute calibration of low-energy and low-specific-activity β-emitters was studied. It was concluded that this method does not provide any advantages as compared with the conventional methods as long as the active substance is not converted to a stable complex form which is completely soluble in the liquid scintillator. (auth)

15370 DETERMINATION OF URANIUM IN CAST IRON. H. Green. BCIRA (Brit. Cast Iron Res. Assoc.) J., 12: 632-3(Sept. 1964).

A chemical method for determining 0-1% uranium in iron, using liquid anion exchanger to extract the uranium from H_2SO_4 solution is described. In alkaline solutions, uranium reacts with H_2O_2 to give yellow peruronates. Optical density of the solution was measured on a spectrophotometer. (Rev. Metal Lit., 21: Dec. 1964)

15371 THE RADIOACTIVATION ANALYSIS OF GRAPHITE FOR NITROGEN BY THE $^{14}N(p,\alpha)^{11}C$ REACTION. Tadashi Nozaki and Kazuhiko Yazawa (Inst. of Physical and Chemical Research, Tokyo and Univ. of Electro-Communications Chofu, Tokyo). Bull. Chem. Soc. Japan, 37: 1891-2(Dec. 1964).

Analysis of graphite for ultra-small quantities of nitrogen is discussed. Using the $^{14}N(p,\alpha)^{11}C$ reaction, amounts of nitrogen as small as several tens of parts per billion were determined in graphite. After irradiation the sample was oxidized to carbon dioxide. The decay curve and gamma spectra were used for determination of the ^{11}C. (M.C.G.)

15372 p-NITROBENZENE AZOCHROMOTROPIC ACID (CHROMOTROPE 2B) AS A COLORIMETRIC REAGENT FOR THORIUM. Satendra P. Sangal (Univ. of Allahabad, India). Bull. Chem. Soc. Japan, 38: 141-2(Jan. 1965).

Chromotrope 2B (p-nitrobenzene azochromotropic acid) was studied as an indicator in the EDTA titration of thorium. The sensitivity as defined by Sandell was found to be 0.232 γ/cm^2. The system adhered to Beer's law from 0.74 to 16.6 ppm of thorium between pH 3.0 and 6.5 from 5 to 95°C. The sensitivity based on an absorbance of 0.01 unit at 580 mμ was 2.32 γ/cm^2. (M.C.G.)

15373 CORRECTION OF MATRIX EFFECT ON THE X-RAY FLUORESCENT DETERMINATION. (DETERMINATION OF ZINC IN THE COPPER-NICKEL ALLOYS. II). Akinari Ichiryu and Toshio Sawada (Sumitomo Light Metal Industries, Ltd., Nagoya, Japan). Bunseki Kagaku, 14: 7-12(Jan. 1965). (In Japanese)

In the x-ray fluorescence determination of zinc in copper-nickel alloys, the zinc Kα line at the first order with the strongest fluorescence intensity came near the CuKβ and WLα lines using tungsten as a target and LiF as an analyzing crystal. The ZnKβ line at the first order was also inseparable from WLβ under the above condition. Therefore, the ZnKα line at the second order was selected as a measuring line. The ZnKα intensity was weakened with increasing nickel concentrations, because nickel had an absorption effect on ZnKα. The theoretical correction of this matrix effect was given by a formula including a constant value, k, determined experimentally together with mass absorption coefficients for ZnKα depending on the sample composition. A simpler equation, with only one constant coefficient was derived from this equation, for the quality control of copper-nickel alloys. Satisfactory results for determination of zinc in copper-nickel alloys were obtained in comparison with chemical analysis. And the method was modificated to be applied for determination of zinc in aluminum alloys and a good agreement was obtained. (auth)

15374 THE COMBINATION OF NEUTRON ACTIVATION ANALYSIS WITH PAPER CHROMATOGRAPHY. Miloslav Rakovic (Charles Univ., Prague). Chem. Listy, 58: 1141-6(1964). (In Czech)

The use of neutron activation as a means of quantitative evaluation of paper chromatograms is reviewed. It was concluded that the use of neutron activation analysis in conjunction with paper chromatography has several advantages. It makes possible a quantitative evaluation directly on the paper. It also makes possible the use of neutron activation analysis for determination of organic compounds. The separation before activation, which with other separation procedures is disadvantageous, eliminates the necessity of carrying out chemical operations with radioactive materials. The sensitivity of detection of individual spots on the paper chromatogram is higher than with the use of other detection techniques. The disadvantages of using this separation method with activation are: limitation of the theoretical sensitivity as a consequence of the fact that the time of activation is limited by the resistance of the chromatogram to radiation damage and limitation of the sensitivity by the influence of impurities in the paper used for the chromatogram. (TTT)

15375 COMPLEXOMETRIC PHOTOMETRIC TITRATION OF MICROGRAM AMOUNTS OF RARE-EARTH ELEMENTS. Hou-Chi Wong and Cheh-Ching Wu. Hua Hseuh Hseuh Pao, 29: 352-6(1963).

Arsenazo III forms green complexes (max. absorption at 660 mμ) with rare earths at pH 4.6 to 6.4, and can be used as an indicator in photometric titration with 0.0001M EDTA. The end-point was calculated by the equation of Ringbom and Vänninen (Anal. Chim. Acta, 11, 153(1954)). The method gives satisfactory results for La, Gd, Tm,

Yb, and Y in the range 3 to 9 μg, and is applicable to the determination of total rare earth content. No interference is caused by the presence of Ca and Mg, and Al and Cr are masked with sulfosalicylic acid. Iron, Cu, and Mn interfere and are removed by solvent extraction at pH 4 with 1% Na diethyldithiocarbamate solution in $CHCl_3$. (Analytical Abstr., 12: No. 1, Jan. 1965)

15376 ALLOY ANALYSIS AND COATING WEIGHT DETERMINATION USING γ-RAY EXCITED X-RAY SOURCES. J. A. Hope and J. S. Watt (Australian Atomic Energy Commission, Sydney). Intern. J. Appl. Radiation Isotopes, 16: 9-14(Jan. 1965). (AAEC/TM-260)

The use of γ excited x-ray sources in conjunction with x-ray fluorescence techniques for analysis of alloys and for determination of coating weight per unit area is described. The sensitivity of the technique is such that a 1% change in counting rate is caused by introduction of about 100 ppm of cadmium in zinc or antimony in lead and by 0.002 mg/cm² of tin on steel (tinplate) or silver in photographic film emulsion. (auth)

15377 CO-SEPARATION OF RADIUM IONS IN AQUEOUS SOLUTION WITH LANTHANUM FLUORIDE PRECIPITATES. G. G. J. Boswell and R. W. Hayes (Royal College of Advanced Tech., Salford, Lancs, Eng.). Intern. J. Appl. Radiation Isotopes, 16: 53-6(Jan. 1965).

An investigation was made to determine how much radium is co-separated on lanthanum fluoride under the conditions that are normally used in the determination of traces of Pu. The radium fraction was determined by comparing the α-activity of the precipitate with the activity of a radium standard. Maximum count rate was observed when the thickness of the La precipitate was 0.20 mg La/cm². Higher thicknesses produced a steady decrease in count rate due to self-absorption of the radium α-particles. The recovery of radium decreased when the amount of La was less than 0.5 mg (in 5 ml of solution). The radium recovery also decreased rapidly below pH 3.7 as the surface of the precipitate became positively charged. The recovery of radium may also be reduced to less than 1% by adding barium chloride to the solution until the barium concentration is 10 g/l. It was concluded that the proportion of radium co-separated with Pu in an analysis will depend upon the particular conditions chosen by the analyst. (P.C.H.)

15378 THE RADIOIODIDE SEQUESTERING ACTION OF THE SILVER HALIDES. L. J. Anghileri (Comision Nacional de Energia Atomica, Buenos Aires). Intern. J. Appl. Radiation Isotopes, 16: 61-3(Jan. 1965).

A study was made to determine the behavior of AgI and AgCl as radioiodine sequestering agents under different conditions of temperature, pH, and concentration of iodide, NaCl, or an organic colloid (gelatin). With carrier-free iodide, both halides behaved similarly (possibly due to similar adsorption phenomena), but when the KI concentration was increased to 10^{-4}M the sequestering action of AgI was higher than that of AgCl. AgCl showed a maximum sequestering action at a concentration of 10^{-3}M. The effects of NaCl concentration indicated that between 5×10^{-4} and 5×10^{-2}M, the sequestering action was almost the same, but at a concentration of 0.05M, it dropped suddenly for AgCl and had a maximum for AgI. In the presence of gelatin, the sequestering action decreased slowly for both halides with increasing colloid concentration. The sequestering action increased almost uniformly with increase of temperature. AgI was always slightly higher than AgCl. The sequestering action for AgI was almost the same over a wide range of pH, but AgCl showed maximum activity at pH 2.0. It was concluded that when the concentration of the carrier-iodide is unknown, it is reasonable to use a mixture of both halides. (P.C.H.)

15379 A PLASTIC SCINTILLATOR METHOD FOR THE RADIOASSAY OF H^3- AND C^{14}-LABELLED COMPOUNDS ON FILTER PAPER. M. M. Nakshbandi (Middlesex Hospital Medical School, London). Intern. J. Appl. Radiation Isotopes, 16: 157-64(Mar. 1965).

A simple and efficient technique for the radioassay of ^3H- and ^{14}C-labeled compounds on filter paper is described. The technique consists in laying a paper tissue soaked in a solution of plastic scintillator in benzene at a concentration of ~200 g/l, and placed onto each side of the filter paper supporting the activity. The sample is then held for a few minutes in benzene vapor to prevent premature evaporation of the solvent and dried at a temperature of about 60°C. The dried sample is then placed vertically in an otherwise empty counting vial and counted in a conventional Tri-Carb liquid scintillation spectrometer. Efficiencies of about 20% were obtained for tritiated non-polar compounds, and of about 10% for tritiated polar compounds. The use of dioxane as a solvent for the plastic scintillator appears to be advantageous when counting tritiated polar compounds on filter paper. The assay of ^{14}C-labeled compounds on filter paper gave exceptionally good results using this technique. (auth)

15380 THE ISOTOPIC ANALYSIS OF OXYGEN IN ORGANIC COMPOUNDS AND IN CO-ORDINATION COMPOUNDS CONTAINING ORGANIC LIGANDS. J. Aggett, C. A. Bunton, T. A. Lewis, D. R. Llewellyn, Charmian O'Connor, and A. L. Odell (Univ. of Auckland, N. Z. and University Coll., London). Intern. J. Appl. Radiation Isotopes, 16: 165-70(Mar. 1965).

An apparatus was developed for the pyrolysis of oxygen-containing organic compounds and co-ordination compounds with organic ligands. The oxygen is obtained as carbon monoxide or carbon dioxide for mass spectrometric analysis. If necessary, carbon monoxide can be converted to carbon dioxide by an electric discharge. (auth)

15381 SEPARATION OF MANGANESE-54 FROM NEUTRON-IRRADIATED IRON BY PREFERENTIAL EVAPORATION. R. Smith and R. Shuttleworth (Univ. of Leeds, Eng.). Intern. J. Appl. Radiation Isotopes, 16: 212-14 (Mar. 1965).

A method is described for the separation of ^{54}Mn produced by the nuclear reaction $^{54}Fe(n,p)^{54}Mn$ by preferential evaporation. An iron foil was heated for successive times at 1200°C. The temperature was then increased to 1400°C and further Mn evaporated. On increasing the temperature to 1450°C no further Mn evaporated, showing that all the Mn had evaporated in 6 hr at 1400°C. (P.C.H.)

15382 FACTORS INFLUENCING THE PRECISION OF THE LUMINESCENT METHOD FOR URANIUM DETERMINATION. V. Mihailova and H. Raichev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 115-20(1964). (In Russian)

The different factors influencing the process of preparation and photometry of uranium beads were investigated. These include dependence of photoluminescence on the kind of flame used, quantity of the melting mixture, time of stay in the oxidation zone of a benzene burner flame, and the necessary time interval preceding the photometry of the beads. Besides this, the values of the correction coefficients were established by comparing the photoluminescence of uranium beads, with that of uranium glasses. The results thus obtained make it possible to attain a greater precision for uranium determination by the luminescent method. (auth)

15383 DETERMINATION OF RADIOACTIVE PHOSPHORUS. Richard B. Hahn (Wayne State Univ., Detroit) and Harley H. Ross. J. Am. Water Works Assoc., 57: 231-3(Feb. 1965).

A method was developed for determination of ^{32}P in water. The phosphorus activity is concentrated from the water by coprecipitation with aluminum hydroxide. The precipitate is dissolved in perchloric acid and a manganese dioxide scavenging step is performed to remove radioniobium. Phosphorus is then separated from other activities by extraction of the phosphomolybdate into a butanol–chloroform mixture. The phosphorus is back-extracted into ammonia and precipitated as magnesium ammonium phosphate, which is weighed and beta-counted. (M.C.G)

15384 DETERMINATION OF RADIOACTIVE COBALT. Richard B. Hahn and Richard H. Marsh (Wayne State Univ., Detroit). J. Am. Water Works Assoc., 57: 234-8(Feb. 1965).

Methods of determining ^{60}Co in water are discussed. A spectrophotometric procedure was developed in which radiocobalt is concentrated from the water by precipitation as cobalt hydroxide. The precipitate is dissolved in nitric acid and then converted to the complex thiocyanate, which is extracted into methylisobutyl ketone. The cobalt is back-extracted into water and precipitated as potassium cobaltinitrite, which is dissolved in nitric acid to form soluble cobalt nitrate. This solution is gamma-counted with a well-type scintillation counter. Recovery of cobalt carrier is determined by measuring the absorbance of the cobalt nitrate solution at 510 mμ. (M.C.G.)

15385 THRESHOLD RADIOACTIVITY FOR BULK FOOD SAMPLES BY GAMMA SPECTROSCOPY. Harry M. Yakabe and Hiram Neilson (Div. of Pharmacology, Food and Drug Administration, Washington, D. C.). J. Assoc. Offic. Agr. Chemists, 48: 1-5(Feb. 1965).

In the surveillance of bulk food produce by gamma spectroscopy for fission products, the activities of the commonly observed radionuclides are frequently in the magnitude of background inherent to the detection system. The problems of determining whether the sample is in fact contaminated, the lower limits of detecting the radionuclides, and the effect of Compton smear on the lower limits are discussed. The discussions are based on the modified spectrum stripping method for quantitative analysis of gamma spectrum for the following radioisotopes: ^{137}Cs, $^{95}Zr/^{95}Nb$, and ^{40}K. A family of curves are shown for rapid determination of the minimum detectable true activity (A_{II}) of ^{137}Cs. (auth)

15386 THE SPECIFICITY OF DI-(2-ETHYLHEXYL) PHOSPHORIC ACID (HDEHP) METHOD FOR YTTRIUM-90 IN FOODS: MODIFICATION FOR FRESH HEAVY FALLOUT CONDITIONS. Alphonso Arnold and Sidney Davis (Div. of Pharmacology, Food and Drug Administration, Washington, D. C.). J. Assoc. Offic. Agr. Chemists, 48: 5-9(Feb. 1965).

Di-2-ethyl phosphoric acid reagent from two commercial sources was investigated for a study of specificity of determining yttrium-90. Titration curves indicate no significant quantity of monoalkyl phosphoric acid ester, the only limiting impurity expected. The following radionuclides in pure solution were examined for removal of activity from ^{90}Y: $^{106}Ru/^{106}Rh$, $^{95}Zr/^{95}Nb$, $^{144}Ce/^{144}Pr$, ^{45}Ca, ^{99}Mo, ^{65}Zn, ^{51}Cr, ^{59}Fe, $^{140}Ba/^{140}La$, ^{137}Cs, $^{147}Nd/^{147}Pr$. Both sources of reagent were highly effective in removal of activity of the introduced radionuclide. The removal of activity to within 0.1% of that initially introduced was demonstrated in all cases except the $^{144}Ce/^{144}Pr$ pair; in this case activity was reduced to within the 0.1% range by substituting a 0.1M HCl wash for the normal wash at pH 1.4. Data are included for the precision of the HDEHP method relative to picocuries of food ash analyzed and the standard deviation of the analysis. (auth)

15387 CHROMATOGRAPHIC, ELECTROPHORETIC, AND ION EXCHANGE IDENTIFICATION OF RADIOACTIVE ORGANIC AND INORGANIC ARSENICALS. L. R. Overby, S. F. Bocchieri, and R. L. Fredrickson (Abbott Labs., North Chicago, Ill.). J. Assoc. Agr. Chemists, 48: 17-22(Feb. 1965).

Paper chromatographic, paper electrophoretic, and ion exchange methods were developed for qualitative and quantitative estimation of arsenate-^{74}As, arsenite-^{74}As, and arsanilic-^{74}As acid. The methods were also applicable to closely related organic arsenicals. The high energy of the isotope permitted detection and identification of trace quantities of the arsenicals present in biological specimens. (auth)

15388 DETERMINATION OF MICROAMOUNT OF ALUMINUM, CHROMIUM, COPPER, IRON, MANGANESE, MOLYBDENUM AND NICKEL IN PURE WATER BY EXTRACTION PHOTOMETRY. Kenji Motojima and Nasumi Ishiwatari (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 13-17(Jan. 1965).

Aluminum, iron(III), copper, and molybdenum 8-quinolinol complexes, chromium(III) and manganese 8-hydroxyquinaldine complexes, and nickel dimethylglyoxime complex can be quantitatively extracted into chloroform from large volumes of aqueous phases adjusted to an appropriate pH for each metal. These metals can be determined by measuring the absorbance of the organic phases containing their complexes at an appropriate wavelength for each metal. By the proposed method, quantities exceeding 3 ppb of aluminum, chromium, and manganese, and 5 ppb of copper, iron, molybdenum, and nickel can be determined when a 500 ml sample of water is available. (auth)

15389 THE DETERMINATION OF ZIRCONIUM IN COPPER–ZIRCONIUM ALLOYS. D. G. Stern. Metallurgia, 71: 51-2(Jan. 1965).

A method was developed for the quantitative determination of zirconium in copper–zirconium alloys in which the sample is dissolved in a hydrochloric-nitric acid mixture and fumed with perchloric acid. After the addition of hydrochloric acid and thioglycollic acid, the latter to suppress interference from iron, the zirconium is reacted with alizarin red S under controlled conditions and the optical density of the zirconium–alizarin lake measured; the zirconium content is read from a calibration graph. (auth)

15390 A MICROMETHOD FOR THE DETERMINATION OF DEUTERIUM OXIDE IN BIOLOGICAL FLUIDS. M. D. Turner, William A. Neely, Ruby Adcock, and Anne C. Turner (Univ. of Mississippi Medical Center, Jackson). Microchem. J., 8: 395-401(Dec. 1964).

A simple micromethod for the determination of deuterium oxide in blood plasma is described. Other fluids of low protein content may be distilled directly without precipitation. This procedure can be carried out on as little as 0.3 ml of plasma and is therefore suitable for measuring D_2O in body fluids of experimental animals as small as mice. (auth)

15391 PROBLEMS OF THE ACTIVATION ANALYTICAL DETERMINATION OF ARSENIC IN SELENIUM. W. Roehnsch (Institut fur Angewandte Radioaktivitat, Leipzig and Deutsche Akademie der Wissenschaften, Berlin). Mikrochim. Ichnoanal. Acta. No. 6, 1164-74(1964). (In German)

The activation-analysis determination of arsenic in selenium was perturbed by the Se(n,p)As reaction. Effective (n,p) cross sections of ^{74}Se, ^{76}Se, and ^{77}Se are given for various irradiation conditions and simulated arsenic contents. Possibilities of correction are discussed. A method is described for the separation of selenium before irradiation. (tr-auth)

15392 RAPID DETERMINATION OF D_2O CONTENT IN WATER USING A VAPOUR PRESSURE OSMOMETER. E. Lazzarini (Centro Studi Nucleari E. Fermi, Politecnico, Milan). Nature, 204: 875-6(Nov. 28, 1964).

Determinations of D_2O content in water were carried out by means of a vapor pressure osmometer. The principle of the instrument is outlined, and the experimental method is discussed. (C.E.S.)

15393 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM IN IRON AND STEEL WITH ARSENAZO III. Masao Kawahata, Heiichi Mochizuki, Rokuro Kajiyama, and Koshiro Ichihashi (Nippon Yakin Kogyo Co., Ltd., Kawasaki, Japan). Nippon Kinzoku Gakkaishi, 28: 619-22 (1964). (In Japanese)

Quantitative determination of thorium in iron and steel by spectrophotometric methods using arsenazo III was investigated. Thorium–arsenazo III complex showed maximum absorbance at 665 mμ and the concentration of HCl did not affect the determination at 4 to 7N. The interference by zirconium complex with arsenazo III could be eliminated by adding oxalic acid and was masked most effectively in a 2.5N HCl medium. The coloration followed Beer's law over the range of 0 to 30 μg thorium at 2.5N HCl in 50 ml for a 30 mm cell. Up to 10 mg Al^{3+}, 20 mg Fe^{3+}, 3 mg Ni^{2+}, and 1 mg Pb^{2+} didn't interfere the determination of thorium. The sample, after decomposition with mixed acid and perchloric acid, can be treated for the separation of iron and other metals by magnetic electrolysis with the use of a mercury cathode. The solution is

diluted exactly by 250 ml and an aliquot is taken. After evaporating the residue is dissolved in 10 ml of HCl(1+1) and transferred to a 50-ml volumetric flask. Then 1.4 ml of saturated oxalic acid in HCl(1+1), 15 ml of 4% oxalic acid solution, ascorbic acid to reduce the iron (III), and 5 ml of 0.05% solution of arsenazo III are added to the solution diluted with water. The photometric determination is carried out at 665 mμ in 30 mm cell. The thorium content is found via a calibration curve. By this means, 0.010% thorium in iron and steels could be determined with satisfactory results. (auth)

15394 A METHOD OF ANALYSIS OF RARE GASES RELEASED FROM NUCLEAR FUEL IN U^{235} THERMAL FISSION. P. Amadesi and A. Cervellati (Universita, Bologna). Nucl. Instr. Methods, 33: 45-52(Mar. 1, 1965).

Nuclear fuel enriched with ^{235}U is irradiated, and the fission gases released are analyzed for Kr and Xe whose separation is carried out by gaschromatography. Proportional counting allows the determination of isotopic composition and activity of these gases. Therefore it is possible to determine the concentration in air and the release coefficients of nuclear fuel for fission rare gases. Experimental results are then critically discussed, and conclusions are drawn in order to improve the method and to make it more widely applicable. (auth)

15395 TITRATION OF CERIUM(IV) SULFATE WITH SODIUM OXALATE AT ROOM TEMPERATURE USING NITROFERROIN AS INDICATOR. K. Bhaskara Rao (Hindustan Aircraft Ltd., Bangalore, India). Rec. Trav. Chim., 84: 62-4(Jan. 1965).

A procedure is reported for the titration of ceric sulfate with sodium oxalate at room temperature. The procedure consists in the titration of ceric sulfate with sodium oxalate in about 0.5N nitric, perchloric, or hydrochloric acid media, using nitroferroin as indicator. (auth)

15396 TITRATION OF MOLYBDENUM(V) WITH CERIC SULFATE, USING METHYL ORANGE AND METHYL RED AS INDICATORS. K. Bhaskara Rao (Hindustan Aircraft Ltd., Bangalore, India). Rec. Trav. Chim., 84: 71-3(Jan. 1965).

The suitability of Methyl Orange and Methyl Red as indicators in the titration of molybdenum(V) with ceric sulfate was investigated. It was found that molybdenum(V) can be titrated with ceric sulfate at room temperature in hydrochloric acid medium with 2 to 3 drops of 0.2% Methyl Orange as indicator; and in sulfuric acid medium with 2 to 3 drops of 0.2% Methyl Orange or Methyl Red as indicator. (auth)

15397 EMISSION SPECTROMETRIC DETERMINATION OF THE GASEOUS ELEMENTS IN METALS. VIII. ESTABLISHMENT OF A MASTER ANALYTICAL CURVE FOR OXYGEN WITHOUT STANDARD SAMPLES. Velmer A. Fassel and John W. Goetzinger (Ames Lab., Ames, Iowa). Spectrochim. Acta, 21: 289-93(Feb. 1965). (IS-961)

An important problem encountered in establishing analytical curves for the emission spectrometric determination of oxygen in metals is the lack of reliable standard samples. It is shown that analytical curves obtained from blends of argon and carbon monoxide or from the quantitative release of carbon monoxide from metal oxides in arc discharges are congruent with the curves obtained from a variety of analyzed metal specimens. These calibration methods therefore provide a simple means for establishing an analytical curve applicable to many metal systems. (auth)

15398 DETERMINATION OF THE MEASURING LINE BACKGROUND IN X-RAY FLUORESCENCE ANALYSIS. Th. Tuchscheerer (Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Anal. Chem., 207: 1-4(1965). (In German)

Conditions are presented that have to be fulfilled by the background value in x-ray fluorescence analysis. It is shown that in the estimation of low amounts of Sr under extreme conditions the determination of the background can be performed in the usual way. (auth)

15399 RADIOCHEMICAL DETERMINATION OF CAESIUM-137 IN LIQUID MILK. K. Juznic, M. Senegacnik, and Z. Milavec (Nuclear Inst. "Jozef Stefan," Ljubljana, Yugoslavia). Z. Anal. Chem., 207: 193-7(1965).

A simple and rapid method is described for the radiochemical determination of ^{137}Cs in liquid milk. After the addition of cesium carrier the milk sample is deproteinized with nitric acid, filtered, and alkaline earths removed by oxalate precipitation. From the decanted solution cesium is precipitated with sodium cobaltinitrite, separated from potassium as cesium silicotungstate, and finally counted as dipicrylaminate by an anticoincidence beta counter. The radiochemical yields for cesium amounted to about 65%. Good agreement was found between results obtained by the present method and by gamma spectrometry. The results for ^{137}Cs content may be obtained within 6 hours. (auth)

15400 POLAROGRAPHIC DETERMINATION OF URANYL IONS IN A HYDROLYZED SYSTEM. Vaclav Baran and Milan Tympl (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anal. Chem., 208: 86-92(1965).

A method for the polarographic determination of nonhydrolyzed uranyl ions in the presence of their hydroxo complexes was developed. Neither hydroxo complex reduction, nor catalytic reduction of nitrate, nor UO_2^+ disproportionation (negligible at pH values > 1) interfered with this determination. A 0.1M $NaNO_3$ or $NaClO_4$ solution was used as the supporting electrolyte. For determination of the total uranium concentration in a hydrolyzed solution, the presence of the corresponding acid in a concentration of about 5×10^{-2}M was necessary, in addition to the sodium salt mentioned above. (auth)

15401 DETERMINATION OF URANIUM AND THORIUM IN SEDIMENT ROCKS OF THE CARBONIFEROUS FORMATION. Heinrich Siemes and Ewald Schwarz. Z. Erzbergbau Metallhuttenw., 17: 306-11(June 1964). (In German)

Apparatus and techniques for determining gamma energy spectrum in powdered rock specimens of 2 kg wt and their use in the quantitative determination of U and Th contents are described. Comparison was made of results obtained in x-ray fluorescence analysis and gamma energy spectroscopy. (Rev. Metal Lit., 21: Dec. 1964)

15402 DETERMINATION OF TRACES OF GOLD BY A RADIOACTIVATION METHOD USING SUBSTOICHIOMETRIC SEPARATION. I. P. Alimarin and G. A. Perezhogin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 20: 48-54(1965). (In Russian)

The possibility of using solvent extraction of salts of metal-containing acids with large organic cations for substoichiometric separation in radioactivation analysis was studied. A radioactivation technique was developed for the determination of traces of gold (down to 5×10^{-11}) in pure Zn, Cu, Bi, Pb using substoichiometric separation. (auth)

15403 ON THE USE OF AROMATIC PHOSPHONIC ACIDS FOR THE DETERMINATION OF RARE ELEMENTS. D. I. Ryabchikov and Yu. M. Dedkov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 20: 128-30(1965). (In Russian)

Methanolphospholacidhexaren (methaphosphol) was suggested for precipitating a number of rare elements. Zirconium can be precipitated with this reagent from concentrated hydrochloric acid. (auth)

15404 OXYGEN AND NITROGEN DETERMINATION IN COLUMBIUM AND TANTALUM BY INERT GAS FUSION EMPLOYING CHROMATOGRAPHIC DETECTION. Francis T. Coyle and William C. Gannon (Kawecki Chemical Co., Boyertown, Penna.). 8p. (CONF-721-8)

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

Commercial instruments were used for the routine analysis of Nb and Ta for N and O, using inert-gas fusion with chromatographic separation and determination. Sample calibration curves are given. The results of the method are compared with these of other prevalent methods, and precision data are given. (D.L.C.)

15405 MASS SPECTROMETRY — APPLICATIONS OF ISOTOPE DILUTION TO THE ANALYSIS OF METALS.

M. Freegarde (Naval Ordnance Inspection Establishment, Sheffield, Eng.). 13p. (CONF-812-2)

From Society for Applied Spectroscopy 3rd National Meeting, Cleveland, Sept.–Oct. 1964.

The thermal ionization process is discussed. The advantages and limitations of the isotope dilution technique are outlined. Ionization potentials of the elements in the periodic table were used to select the elements for possible mass spectrometric determination. These elements include B, Li, Ca, Sr, Ba, Zr, Hf, Ti, Ta, and rare earths. (D.L.C.)

15406 ANALYSIS OF ZIRCONIUM METAL AND ALLOYS FOR HYDROGEN, CARBON AND OXYGEN. H. R. Weiler, Jr. (Carborundum Metals Co., Inc., Akron, N. Y.). 9p. (CONF-721-12)

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

The methods used for determination of hydrogen, carbon, and oxygen in zirconium and zirconium alloys are presented. Hydrogen is determined by hot extraction in vacuum. Oxygen is determined by fusion in inert gas and conductometric analysis. Carbon is oxidized to carbon dioxide and analyzed conductometrically. (auth)

15407 THE DETERMINATION OF OXYGEN IN RUBIDIUM AND CESIUM. Sheridan J. Rodgers and Frederick Tepper (MSA Research Corp., Callery, Penna.). 11p. (MSAR-64-108; CONF-721-10)

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

A technique and apparatus were developed for the determination of oxygen in rubidium and cesium. The inadequacies of the standard amalgamation method developed by Pepkowitz and Judd for analysis of oxygen in sodium as well as the butyl bromide method are discussed. A modification of the amalgamation method is described. The freezing point depression of cesium and rubidium as a function of oxygen content was determined and found to be 0.0024°C/ppm O_2 for cesium and 0.0017°C/ppm O_2 for rubidium. This effect was used as a means of monitoring the oxygen content of these metals. A device for transfer of rubidium and cesium and measurement of the freezing point is described. (auth)

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Refer also to abstracts 15662, 16040, 16051, 17151, and 17174.

15408 (ANL-6900(p.221-31)) CALORIMETRY. W. N. Hubbard and H. M. Feder (Argonne National Lab., Ill.).

The technique developed for calorimetric combustions of the diborides of Zr and Nb in F_2 was applied to the diborides of Hf and Ta. Preliminary data for hafnium diboride are presented. They lead to a value of −73.7 kcal $mole^{-1}$ for the enthalpy of formation of $HfB_{2.91}$. A series of combustions (15) of silicon carbide in F_2 was carried out. Four different samples, two of the alpha- and two of the beta-crystalline modifications, were burned. The preliminary results showed no difference between the enthalpies of formation of the two modifications, within the precision of the measurements; they also showed that the impurity corrections, which differed for each of the samples, could be reliably computed. Preliminary experiments on combustions of US and of graphite in a F_2 flow reactor were performed. The results indicate that the reactions are suitable for calorimetric measurements. A F_2 flow calorimeter is being designed and built. A new arrangement was developed for burning metals which form nonvolatile fluorides in F_2. The sample is suspended at the top of a bomb which is completely lined with the fluoride of the metal to be burned. With this arrangement the sample, once ignited, becomes hot enough to sustain combustion in the vapor phase even after dropping to the bottom of the bomb. The 1500°C drop calorimeter was completely assembled. It is being evaluated by making drops with a heated Cu sample into the Cu block calorimeter. The latter has been calibrated electrically. Nearly all of the components of the 2500°C drop calorimeter furnace were fabricated. (J.R.D.)

15409 (COO-1197-12) SELF-DIFFUSION OF THE SILVER ION IN PURE SILVER CHLORIDE. Max D. Weber (Kansas Univ., Lawrence). Nov. 1964. Contract AT(11-1)-1197. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The ionic conductivity σ and the radioactive tracer diffusion coefficient D_{Ag^*} of ^{110}Ag ions in pure AgCl crystals were measured in the intrinsic temperature region. The calculated correction factors D_{Ag^*}/D_O is discussed with respect to the various defect mechanisms of conduction: direct interstitialcy jump, noncollinear interstitialcy jump, and collinear interstitialcy jump. (D.L.C.)

15410 (EUR-2189.f) STABILITE THERMIQUE DU TRICHLORURE D'URANIUM. (Thermal Stability of Uranium Trichloride). C. Hardy-Grena (European Atomic Energy Community, Ispra (Italy)). Joint Nuclear Research Center. Dec. 1964. 25p. Dep.(mn).

The thermal stability of UCl_3 was investigated in the temperature range 750–900°C. From the study it is concluded that UCl_3 decomposes: $4\langle UCl_3\rangle \longrightarrow 3(UCl_4) + \langle U\rangle$. The vapor pressure was determined and thermochemical data calculated. (auth)

15411 (JINR-E-1930) DETERMINATION OF PARAMETERS OF THE ROTATIONAL DYNAMICS OF GROUPS NH_4 IN NH_4ClO_4 AND H_3O IN H_3OClO_4 BY MEANS OF INELASTIC SCATTERING OF NEUTRONS. J. M. Janik, J. A. Janik, A. Bajorek, and K. Parlinski (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 11p. Dep.(mn).

Measurements of inelastic neutron scattering on NH_4ClO_4 and H_3OClO_4 were made from liquid nitrogen temperature up to room temperature. The absence of peaks in the spectrum of inelastic neutron scattering from NH_4ClO_4 points to freedom of rotation for NH_4 groups. In the spectrum of neutrons scattered on H_3OClO_4, a 0.062-ev peak was observed which is interpreted as that due to hindered rotations of the NH_4 group. (auth)

15412 (KFK-225) ÜBER DIE FESTKORPERCHEMIE DER ACTINIDEN-OXIDE. (The Solid-State Chemistry of the Actinide Oxides). Cornelius Keller (Kernforschungszentrum, Karlsruhe (West Germany). Institut für Radiochemie). Feb. 1964. 261p.

A bibliographic review is made of the solid-state chemistry of the ternary and polynary oxides and oxide phases of the actinide elements Th, Pa, U, Np, Pu, Am, and Cm. The general and special methods and the analytical procedures used for the study of these compounds were described. (J.S.R.)

15413 (KFK-246) ZUM ISOTOPENAUSTAUSCH ZWISCHEN EISENPHOSPHAT (P-32) UND EINIGEN EINFACHEN PHOSPHORSAUREESTERN. (Isotope Exchange Between Iron Phosphate (P-32) and Some Simple Phosphoric-Acid Esters). L. Termens (Kernforschungszentrum, Karlsruhe (West Germany). Institut für Radiochemie). Sept. 1964. 110p.

Isotope exchange between iron phosphate (^{32}P) and tributyl phosphate, triethyl phosphate, triphenyl phosphate, and iron-α-glyceryl phosphate was investigated. In the temperature range from 140 to 230°C, an isotope exchange could be detected with tributyl phosphate and triethyl phosphate. Below this temperature range the exchange is not detectable, and over the temperature range the decomposition of the organic phosphates interferes significantly. The activation energy of the isotope exchange reaction was determined as 20.5 kcal/mole for TBP and 24.6 kcal/mole for triethyl phosphate. The exchange was accelerated through the presence of water. This corresponds to an exchange that occurs by hydrolysis of the water. A second exchange mechanism was discussed. With triphenyl phosphate, no exchange was found up to a temperature of 350°C. No exchange was found with iron-α-glyceryl phosphate in the aqueous phase. In the organic phase, the exchange could not be determined with certainty. A special method for

phosphate separation by ion exchange and a colorimetric phosphorus determination was worked out in ion exchange studies with iron-α-glyceryl phosphate. (tr-auth)

15414 (MLM-1163(p.H-1-6)) STUDIES ON THE CHEMISTRY OF POTASSIUM PLUTONIUM SULFATE. W. B. Brown and D. R. Rogers (Mound Lab., Miamisburg, Ohio).

Thermogravimetric and differential-thermal analysis curves were measured for $K_4Pu(SO_4)_4 \cdot 2H_2O$ and compared with those of K_2SO_4 and $Pu(SO_4)_2 \cdot 4H_2O$. The residue from the ignition of $K_4Pu(SO_4)_4 \cdot 2H_2O$ at 850°C apparently is $PuO_{2.00}$. The solubility product constant in water was determined to be $10^{-17.3}$. (D.L.C.)

15415 (ORNL-3714(Vol.I)(p.87-9)) WATER DESALINATION STUDIES—THEORETICAL. (Oak Ridge National Lab., Tenn.).

Research is summarized on demineralization of salt water by reverse osmosis, salt concentrations in desalination processes, and methods for determining salt rejection by hyperfiltration membranes. (J.R.D.)

15416 (ORNL-3761) CRYSTALLOGRAPHIC DATA FOR SOME METAL FLUORIDES, CHLORIDES, AND OXIDES. G. D. Brunton, H. Insley, T. N. McVay, and R. E. Thoma (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 265p. Dep.; $6.00(cy), 4(mn) CFSTI.

Optical and x-ray diffraction data are listed for some 250 compounds, mostly complex fluorides. (auth)

15417 (TID-19078) COMPLEXES OF SOME 1-SUBSTITUTED TETRAZOLES AND Co(II), Ni(II), Pt(II), AND Zn(II) CHLORIDES. G. Gilbert and C. H. Brubaker, Jr. (Kedzie Chemical Lab., Michigan State Univ., East Lansing). [nd]. Contract AT(11-1)-399. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The compounds formed when zinc chloride, nickel chloride, and platinum(II) chloride react with 1-methyltetrazole, 1-cyclohexyltetrazole, and 1-phenyltetrazole in ethanol or tetrahydrofuran have the general formula MT_2Cl_2 (where T = 1-substituted tetrazole). The solids, with the exception of the zinc compounds, are insoluble in common solvents and decompose without melting upon heating. The complexes formed with zinc chloride are moderately soluble in tetrahydrofuran and ethanol and crystallize in clear, well-formed crystals from ethanol. Stability constant measurements with nickel in ethanol and cobalt in tetrahydrofuran yield similar values for the formation constants with 1-methyl- and 1-cyclohexyltetrazole and slightly larger formation constants with 1-phenyltetrazole. (auth)

15418 (UCRL-9821(Rev.)) THE KINETICS OF THE HIGH-TEMPERATURE HYDROLYSIS OF MAGNESIUM FLUORIDE. PART II. INFLUENCE OF CHANGING SPECIMEN GEOMETRY, SPECIMEN TYPE, AND RESISTANCE OF THICK PRODUCT LAYERS ON THE REACTION RATE. Donald R. Messier and Joseph A. Pask (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 7, 1964. Contract W-7405-eng-48. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The kinetics of the reaction between magnesium fluoride and water vapor were gravimetrically determined on three specimen types (single crystal, sintered polycrystalline disk, and powder) in the temperature range from 950 to 1100°C at a water-vapor partial pressure of 55.3 mm Hg. It was found that the rate-influencing effects of changing sample geometry and the formation of thick MgO product layers on samples reacted to large extents complicated the evaluation of the rate measurements. Apparent activation enthalpies of 42, 57, and 23 kcal/mole were obtained for the single-crystal, polycrystalline, and powder specimens, respectively. The deviations of these values from the activation enthalpy of 46.4 kcal/mole reported in Part I of this series are discussed with respect to possible rate-influencing factors. (auth)

15419 (UCRL-11103(Rev.1)) THE KINETICS OF THE HIGH-TEMPERATURE HYDROLYSIS OF MAGNESIUM FLUORIDE. PART I. EVALUATION OF REACTION MECHANISM. Donald R. Messier (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Dep. of Mineral Technology.). Jan. 30, 1964. Contract W-7405-eng-48. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The rates of hydrolysis of polycrystalline magnesium fluoride slabs were investigated by a gravimetric method as functions of temperature and water-vapor pressure over the ranges from 745 to 835°C and 1 to 20 mm Hg respectively. A linear rate law was found, and it was concluded that the rate-determining process was chemical reaction at the MgF_2–MgO interface. A three-step reaction mechanism is proposed. The first step involves the chemisorption of water vapor: $MgF_2(c) + H_2O(g) \rightleftharpoons MgF_2 \cdot H_2O(chem)$. The second step, formation of a hydroxyfluoride complex, can be represented by $MgF_2 \cdot H_2O(chem) \rightleftharpoons Mg(OH)F(c) + HF(g)$. The third step, decomposition of the hydroxyfluoride complex to form products, can be written as $Mg(OH)F(c) \rightleftharpoons MgO(c) + HF(g)$. With the assumptions that the chemisorption step was in equilibrium and that the HF pressure was negligible, an expression was developed showing that the rate was proportional to the concentration of chemisorbed water vapor. It was possible to express the rate dependence on water-vapor pressure in terms of the Langmuir adsorption isotherm equation. Values of −16.9 kcal/mole and −4.2 eu were obtained for the enthalpy and entropy of chemisorption. The activation enthalpy and frequency factor for the decomposition of the chemisorbed intermediate, $MgF_2 \cdot H_2O(chem)$, were determined to be 46.4 kcal/mole and 1.75×10^{10} sec^{-1}. (auth)

15420 (ANL-Trans-33) INVESTIGATIONS IN THE FIELD OF URANIUM CHEMISTRY. V. I. Spitsyn, ed. Translated by Lydia Venters (Argonne National Lab., Ill.), from "Issledovaniya v Oblasti Khimii Urana" (a publication of the Publishing House of Moscow University, 1961). 358p. Dep.; $7.00(cy), 6(mn) CFSTI.

A total of 45 papers are presented which give results of research on the chemistry of various uranium compounds. Some of these compounds include uranates and polyuranates, uranium silicates, sulfides, phosphates, vanadates, etc. Reactions leading to these compounds were also investigated. Separate abstracts were prepared for all the papers. (D.L.C.)

For abstracts of individual papers see: 15421, 15422, 15423, 15424, 15425, 15426, 15427, 15428, 15429, 15430, 15431, 15432, 15433, 15434, 15435, 15436, 15437, 15438, 15439, 15440, 15441, 15442, 15443, 15444, 15445, 15446, 15447, 15448, 15449, 15450, 15451, 15452, 15453, 15454, 15455, 15456, 15457, 15458, 15459, 15460, 15461, 15462, 15463, 15464, and 15465.

15421 (ANL-Trans-33(p.4-16)) NORMAL URANATES OF ALKALI ELEMENTS. V. I. Spitsyn, E. A. Ippulitova, Yu. P. Simanov, and L. M. Kovba. Translated from "Issledovaniya v Oblasti Khimii Urana."

Methods for obtaining normal uranates were worked out which enable one to use the excess of one of the reagents, while its subsequent removal does not lead to hydrolysis of the preparation. The single crystals of α-Li_2UO_4 and β-Na_2UO_4 were obtained and the periods of their unit cells determined. Using the powder method, monouranates of potassium, rubidium, and cesium were studied and the periods of their unit cells determined. It was found that the structures of monouranates of potassium, rubidium, and cesium are related to the structural type K_2NiF_4. The structure β-Na_2UO_4 may be considered to be a distorted rhombic structure of the K_2NiF_4 type. In α-Li_2UO_4, the dominant features of uranyl-oxygen present in β-Na_2UO_4 are maintained, but is more likely that there is another arrangement of the atoms in the alkali element. It is shown that the application of Goldschmidt criterion, suggested for structures of perovskite type, to structures of K_2NiF_4 type is unfounded. (auth)

15422 (ANL-Trans-33(p.17-23)) X-RAY-DIFFRACTION STUDY OF SOME URANATES. L. M. Kovba, G. P. Polunina, Yu. P. Simanov, and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

By alloying U_3O_8 with excess of an appropriate chloride, single crystals of β-$CdUO_4$ and $PbUO_4$ were obtained. The cell parameters of β-$CdUO_4$ and $PbUO_4$ (using Laue, vibration and powder methods) and α-Na_2UO_4 (using the powder method) were determined. In the structures of α-Na_2UO_4 and β-$CdUO_4$, infinite uranyl-oxygen chains $(UO_4)O_2$ of octahedra linked by common edges have been discovered. The sodium and cadmium atoms are situated in octahedral voids between the uranyl-oxygen chains. Lead uranate is isostructural to barium uranate and carries pseudotetragonal $(UO_3)O_2$ layers. (auth)

15423 (ANL-Trans-33(p.24-33)) ON THE CRYSTALLINE STRUCTURE OF DIURANATES OF ALKALI ELEMENTS. L. M. Kovba, Yu. P. Simanov, E. A. Ippolitova, and V. I. Spitsyn. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the vibration, Laue, and powder methods, the single crystals of diuranates of sodium, rubidium, and potassium (α- and β-modifications) were investigated. A compound of composition $NaUO_3F$ isostructural to diuranates mentioned above, was detected. The crystalline structures of $Na_2U_2O_7$, α-$K_2U_2O_7$, $Rb_2U_2O_7$, and $NaUO_3F$ were discovered. In all these structures there are hexagonal layers of $(UO_2)O_{1\frac{1}{2}}$-$(UO_2)OF$ for the case $NaUO_3F$, which are perpendicular to the z-axis. The atoms of the alkali element are located between the layers. The above structures are similar to the structure $CaUO_4$ studied by Zachariasen, but, in contrast to it, it is imperfect (in diuranates statistically is absent each fourth oxygen atom which is not contained in the uranyl grouping, but in $NaUO_3F$, fluorine and oxygen atoms occupy a regular system of points). β-$K_2U_2O_7$ differs from α-$K_2U_2O_7$ by disordered superposition of layers. Diuranates and fluorouranates of sodium produce solid solutions whose lattice spacings are located between the lattice spacings of pure salts. (auth)

15424 (ANL-Trans-33(p.34-43)) INVESTIGATION OF THE COMPOSITION OF SODIUM URANATES PRODUCED BY THE DRY METHOD. E. A. Ippolitova, Yu. P. Simanov, K. M. Efremova, and V. M. Shatskii. Translated from "Issledovaniya v Oblasti Khimii Urana."

The reaction process between Na_2CO_3 and UO_3 was investigated by thermal and x-ray diffraction methods. It was found that during reaction of Na_2CO_3 and UO_3 in ratio 1:1 in the temperature range from 500–520°, sodium diuranate forms which in continued heating (650°) changes to sodium monouranate. At temperature equal to 900–930°, a polymorphous transformation of sodium monouranate (transition from the α-modification to β-modification) occurs. Where there is reaction between Na_2CO_3 and UO_3 or U_3O_8, as well as between sodium monouranate and uranium trioxide in ratio Na:U = 1:1, sodium diuranate forms. In calcination (1000°) of the mixtures of uranium trioxide with sodium monouranate or sodium carbonate, in which the ratio Na:U < 1, only sodium diuranate is produced. The excessive uranium trioxide changes to U_3O_8. The reaction between Na_2CO_3 and UO_3 in ratio 2:1 and 3:1 results in the formation of sodium orthouranate of composition Na_4UO_5; its formation runs through diuranate and monouranate stages. (auth)

15425 (ANL-Trans-33(p.44-51)) INVESTIGATION OF THE COMPOSITION OF POTASSIUM URANATES PRODUCED BY THE DRY METHOD. K. M. Efremova, E. A. Ippolitova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the thermal and x-ray diffraction methods, the composition of products produced in heating K_2CO_3 with UO_3 or U_3O_8 taken in various ratios, was investigated. It was found that regardless of the composition of the initial mixture K_2CO_3 and uranium oxide always potassium diuranate forms first, which then changes to ortho-, mono- or triuranate of potassium, depending on whether there is excess of potassium carbonate or uranium oxide. By subjecting $K_2U_2O_{10}$ to reaction with U_3O_8 taken in adequate ratios, tetra- and hexauranates were obtained. Indexing of the Debye powder pattern of uranate of a composition K_4UO_5 was carried out; its axial parameters were determined. (auth)

15426 (ANL-Trans-33(p.52-8)) INVESTIGATION OF THE COMPOSITION OF RUBIDIUM URANATES PRODUCED BY THE DRY METHOD. E. A. Ippolitova, K. M. Efremova, O. L. Orlinkova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

The composition of products produced during the reaction between Rb_2CO_3 and UO_3 (in various ratios) at high temperature was determined by using the thermal and x-ray diffraction methods. The formation of the compounds Rb_4UO_5, Rb_2UO_4, $Rb_2U_2O_7$, $Rb_2U_4O_{13}$, and $Rb_2U_6O_{19}$, was established. The formation of mono- and orthouranates runs through the diuranate stage. Indexing of the Debye powder pattern of Rb_4UO_5 was performed and its axial parameters found. (auth)

15427 (ANL-Trans-33(p.59-64)) ON THE COMPOSITION OF ANHYDROUS CESIUM URANATES. K. M. Efremova, E. A. Ippolitova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the thermal and x-ray diffraction methods, the composition of products formed during the reaction of Cs_2CO_3 with UO_3 or U_3O_8 at high temperature, was investigated. The formation of the compounds Cs_2UO_4, $Cs_2U_2O_7$, $Cs_2U_3O_{10}$, $Cs_2U_4O_{13}$, and $Cs_2U_6O_{19}$ was ascertained. The formation of monouranate runs through the diuranate phase. At temperature from 985–1000°, tri-, tetra-, and hexauranates disintegrate. (auth)

15428 (ANL-Trans-33(p.65-9)) ON THE COMPOSITION OF ANHYDROUS LITHIUM URANATES. K. M. Efremova, E. A. Ippolitova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the thermal and x-ray diffraction methods, the composition of products formed during reaction of Li_2CO_3 and UO_3 or U_3O_8 at high temperature was investigated. The formation of the following compounds was ascertained: Li_4UO_5, α-Li_2UO_4, β-Li_2UO_4, $Li_2U_2O_7$, and $Li_2U_3O_{10}$; the α-modification of Li_2UO_4 changes to β-modification when heated 60 hours at 1300°. Indexing of the Debye powder pattern of β-Li_2UO_4 and $Li_2U_3O_{10}$ was conducted. Their axial parameters were determined. (auth)

15429 (ANL-Trans-33(p.70-4)) REACTION BETWEEN URANOSO–URANIC OXIDE AND CHLORIDES OF SODIUM AND POTASSIUM. L. M. Vidavskii, L. M. Kovba, E. A. Ippolitova, and V. I. Spitsyn. Translated from "Issledovaniya v Oblasti Khimii Urana."

The reaction between uranoso-uranic oxide and sodium and potassium chlorides was investigated using thermographic, x-ray diffraction, and chemical methods. The reactions begin at 500° and result in formation of uranyl chloride, chlorouranates, and diuranates of sodium and potassium. At increased temperatures, uranyl chloride reacts with sodium and potassium chlorides, forming respective diuranates. Decomposition of chlorouranates caused by heat also leads to formation of diuranates. Chemical analysis of pure, separated sodium chlorouranate gives the composition $NaUO_3Cl \cdot Na_2U_2O_7$. Pure potassium chlorouranate was not separated. (auth)

15430 (ANL-Trans-33(p.75-6)) REACTION BETWEEN URANOSO–URANIC OXIDE AND SULFATES OF SODIUM AND POTASSIUM. L. M. Vidavskii, L. M. Kovba, and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the thermal and x-ray diffraction methods, the reactions of uranoso-uranic oxide with sodium and potassium sulfates were studied. The reaction between uranoso-uranic oxide and sodium sulfate begins at 500°. The reaction results in formation of sodium diuranate and uranyl sulfate, which at higher temperature undergoes reaction producing diuranate. The reaction between potassium sulfate and uranoso-uranic oxide, which begins at 580° is accompanied by the formation of potassium triuranate and uranyl sulfate. With increasing temperature, both these products react with potassium sulfate and form diuranate. (auth)

15431 (ANL-Trans-33(p.77-8)) ON THE REACTION BETWEEN URANOSO–URANIC OXIDE AND NITRATES OF SODIUM AND POTASSIUM. L. M. Vidavskii, L. M. Kovba,

E. A. Ippolitova, and V. I. Spitsyn. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the x-ray diffraction and thermal analytical methods, it was found that the reaction of uranoso-uranic oxide with sodium nitrate begins at 410°. As a result of this reaction, sodium diuranate forms which at higher temperatures (530°) reacts with the nitrate forming sodium monouranate. The reaction of uranoso-uranic oxide with potassium nitrate (the reaction begins at 390°) results in the formation of potassium diuranate. (auth)

15432 (ANL-Trans-33(p.79-88)) AQUEOUS POLYURANATES OF ALKALI ELEMENTS. V. I. Spitsyn and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using potassium uranate as an example, the conditions for obtaining uranates of alkali elements were investigated by treating uranyl salt with alkalis. It was found that the best conditions for obtaining precipitated uranates are as follows: excess of alkali equal to 0.5–0.75 mole, precipitation from hot dilute solutions, addition of the solution of uranyl salt to the solution of alkali, maintenance of the precipitate before filtration for 12–24 hours, washing with hot water (in case of lithium uranate the excess of alkali must be at least a mole and washing must be done with cold water). Uranates of all alkali elements were precipitated from uranyl nitrate solutions using alkali. It was found that during the transition from lithium to cesium, the content of UO_3 in uranates of alkali elements obtained under similar conditions, increases: the ratio of the oxide of alkali metal to uranium trioxide in lithium and sodium uranates is equal to 1:2.5, in potassium uranate 1:3, in rubidium uranate 1:4, cesium uranate 1:4 and even 1:6. Analogous to other complex compounds, with decreasing polarizing action of cations, the co-existence of more complex anions is possible. (auth)

15433 (ANL-Trans-33(p.89-100)) INVESTIGATION OF THE REACTION BETWEEN URANYL NITRATE AND HYDROXIDES OF ALKALI ELEMENTS. E. A. Ippolitova and N. I. Pechurova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using potentiometric, conductometric, and thermometric (in case of NaOH) titrations, the reaction of uranyl nitrate with hydroxides of alkali elements was studied. It was found that at nearly equal pH values regardless of the nature of the hydroxide, analogous compounds form: $UO_2(OH)NO_3$ (pH 2.5–3); $UO_2(NO_3)_2 \cdot 3UO_2(OH)_2$ (pH 3.5–4); $UO_2(OH)_2$ (pH 4–5); $Me_2U_7O_{22}$ (pH 6–6.5); $Me_2U_4O_{13}$ (pH 7–9); $Me_2U_2O_7$ (pH 9–11) and Me_2UO_4 (pH ~12). (auth)

15434 (ANL-Trans-33(p.101-9)) INVESTIGATION OF THE COMPOSITION OF PRECIPITATED SODIUM URANATES. N. I. Pechurova, E. A. Ippolitova, and L. M. Kovba. Translated from "Issledovaniya v Oblasti Khimii Urana."

By means of chemical analysis, the composition of precipitates formed as a result of reaction between uranyl nitrate and sodium hydroxide at various pH values, was investigated. It was found that hydrolyzed products always precipitate from aqueous solutions. The precipitated uranates were investigated by x-ray diffraction and thermal analyses. It is shown that sodium uranates precipitated at pH 11.7 and 10.5, in their structure are nearly identical to anhydrous sodium diuranate and carry hexagonal layers of $UO_2(O,OH)_2$. (auth)

15435 (ANL-Trans-33(p.110-13)) INVESTIGATION OF THE HYDROLYTIC PROCESSES OF NORMAL URANATES OF ALKALI ELEMENTS. N. I. Pechurova, E. A. Ippolitova, and L. M. Kovba. Translated from "Issledovaniya v Oblasti Khimii Urana."

The hydrolysis of normal uranates of lithium, sodium, rubidium, and cesium was studied. It was found that the hydrolysis of normal lithium and sodium uranates leads to formation of products whose composition is nearly identical to that of diuranates. In the hydrolysis of rubidium and cesium monouranates, uranates with higher acidity were obtained. (auth)

15436 (ANL-Trans-33(p.114-26)) INVESTIGATION OF THE REACTION PROCESS BETWEEN URANYL NITRATE AND AMMONIUM HYDROXIDE. E. A. Ippolitova, N. I. Pechurova, and E. N. Gribennik. Translated from "Issledovaniya v Oblasti Khimii Urana."

The reaction between uranyl nitrate and ammonium hydroxide was studied by using potentiometric and conductometric methods. It was found that in the titration curves there are 7 inflection points related to addition of 1, 1.5, 2, 2.30, 2.50, 3.0, and 4.0 moles of ammonium hydroxide per mole of uranyl uranate. According to suppositions, this coincides with the formation of the following compounds: $UO_2(OH)NO_3$, $UO_2(NO_3)_2 \cdot 3UO_2(OH)_2$, $UO_2(OH)_2$, $(NH_4)_2U_7O_{22}$, $(NH_4)_2U_4O_{13}$, $(NH_4)_2U_2O_7$ and $(NH_4)_2UO_4$. It was discovered that the composition of the precipitates agrees more with that of products which are more hydrolyzed than indicated by titration at various pH values. It was established that the residual uranium in mother liquors over precipitates decreases with increasing pH and time as well. The thermal stability of ammonium diuranate has been studied. Based on isobaric dehydration and continuous weighing, the existence of two hydrates of ammonium diuranate was discovered: $(NH_4)_2U_2O_7 \cdot 2.5\ H_2O$ and $(NH_4)_2U_2O_7 \cdot H_2O$. It was found that disintegration of ammonium diuranate occurs in the temperature range from 365–460°. (auth)

15437 (ANL-Trans-33(p.127-41)) ISOTOPIC AND ION EXCHANGE BETWEEN PRECIPITATES OF URANATES AND IONS OF ALKALI ELEMENTS. N. I. Pechurova, L. M. Kovba, and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

The isotopic and ion exchange between precipitates of uranates and ions of alkali metals in solution was studied. It was found that both in the isotopic and the ion exchange, within 30 minutes from the beginning of the experiment there is a considerable decrease in the activity of solutions of alkali chlorides when they get in contact with the precipitates of uranates; during the successive 6–11 hours, the activity of the solution almost does not decrease. The value of the isotopic exchange of sodium, potassium, rubidium, and cesium uranates is of the same order (20–85%). The degree of the isotopic exchange increases with temperature. The ion exchange between lithium uranate and ions of alkali metals in the solution is insignificant (2–8%), probably, due to the large difference in the dimensions of the lithium ions and ions of other alkali metals. The exchange is greatest in sodium ions. The exchange for other ions of alkali metals (Rb,Cs) decreases as their radii increase. The value of the ion exchange between uranates of sodium, potassium, rubidium and cesium, and the ions of alkali elements in solution is of the same order (10–64%). The exchange is less intense in the more difficultly soluble potassium uranate. (auth)

15438 (ANL-Trans-33(p.142-7)) INVESTIGATION OF THE THERMAL STABILITY OF NORMAL URANATES OF ALKALI ELEMENTS. V. I. Spitsyn, E. A. Ippolitova, K. M. Efremova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

The thermal stability of normal uranates of alkali elements in the temperature range from 700–1200° (or 1300°) was investigated. It was established that in transition from Li_2UO_4 to Cs_2UO_4, the thermal stability of normal uranates decreases owing to increasing polarization capacity of cations in this series and volatility of oxides. The end products of thermal decomposition of Na_2UO_4, K_2UO_4, and Rb_2UO_4 are the respective diuranates. Normal uranates of alkali elements are less stable than the respective molybdates and tungstates. (auth)

15439 (ANL-Trans-33(p.148-52)) INVESTIGATION OF THE THERMAL STABILITY OF POLYURANATES OF ALKALI ELEMENTS. V. I. Spitsyn, E. A. Ippolitova, K. M. Efremova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

The thermal stability of polyuranates of alkali elements was investigated. It was determined that diuranates are highly stable, hexauranates less stable. The latter disintegrate approximately at 1000°. In the variation of thermal stability of polyuranates, the same rule as in normal

uranates was observed: the stability of salts decreases in each series from Li to Cs ($Rb_2U_4O_{13}$ among tetrauranates is an exception). The decomposition reaction of some uranates is inverse (decomposition of $K_2U_3O_{10}$). The decomposition of all cesium uranates ends with formation of the same black colored phase and uranium content amounting to 68.7%. (auth)

15440 (ANL-Trans-33(p.153-64)) REDUCTION OF URANATES OF ALKALI ELEMENTS BY HYDROGEN. E. A. Ippolitova, Yu. P. Simanov, L. M. Kovba, I. A. Murav'eva, and A. A. Krasnoyarskaya. Translated from "Issledovaniya v Oblasti Khimii Urana."

The effect of hydrogen on normal uranates of alkali elements at various temperatures was investigated. In normal uranates of lithium, sodium, and cesium the reaction presumably runs through one stage: $Me_2UO_4 + H_2 = 2MeOH + UO_2$ or $Me_2UO_4 + H_2 = Me_2O + UO_2 + H_2O$. When normal potassium uranate is reduced, a phase with composition KUO_3 forms (with a structure of the type $CaTiO_3$) which then is reduced to uranium dioxide. The reduction of normal rubidium uranate is associated with the formation of an intermediate phase, presumably of the composition $Rb_xUO_3 (x \sim 1)$. The reduction of normal sodium uranate does not involve the formation of the phase $NaUO_3$, because the reduction of Na_2UO_4 and $NaUO_3$ takes place approximately at the same temperature (~500°). The reduction process of diuranates of sodium, potassium, and rubidium was also investigated. The reduction of $Na_2U_2O_7$ begins at 380°. In the temperature range from 380–440°, phases are formed whose structure, probably, is nearly identical to that of the initial diuranate, but it contains less oxygen; $NaUO_3$ (its structure is of the perovskite type) forms at 450°, uranium dioxide at 500°. KUO_3(450°) and $UO_{2.22}$(700–800°) are obtained in the reduction of potassium diuranate. In the reduction of rubidium diuranate in addition to uranium dioxide a phase of probable composition Rb_xUO_3 forms. Using $K_2U_3O_{10}$ as an example, it was shown that the reduction of potassium uranates whose acidity is higher than that of diuranates runs through formation of diuranates. The considerable decrease in the weight of uranates during calcination in hydrogen current at 700–800° is associated with marked volatility of hydroxides at these temperatures. In contrast to tungsten bronze, $NaUO_3$, and KUO_3 are not bronze (absence of a phase of varying composition with a wide homogeneity range, chemical properties). The phase UO_2 is the end product in the reduction of uranates. (auth)

15441 (ANL-Trans-33(p.165-9)) TRUE THERMAL CAPACITY OF URANOSO–URANIC OXIDE. K. G. Khomyakov, V. I. Spitsyn, and S. A. Zhvanko. Translated from "Issledovaniya v Oblasti Khimii Urana."

The true thermal capacity of uranoso-uranic oxide in the temperature range from 360–960° was measured. It was found that uranoso-uranic oxide in heating undergoes two transitions at 770 and 940°. It was assumed that uranoso-uranic oxide exists in three phases: α, β, and γ. The temperature equal to 770° is related to the transition of the α-phase to the β-phase, and 940°–β-phase to γ-phase. The heat of transition of uranoso-uranic oxide was calculated; it was found to be equal to 265 ± 5 cal/mole for the transition of the α-phase to the β-phase, and 1105 ± 15 cal/mole for the transition of the β-phase to the γ-phase. (auth)

15442 (ANL-Trans-33(p.170-2)) DETERMINATION OF ENTHALPIES OF FORMATION OF MONOURANATES OF ALKALI ELEMENTS AND CALCIUM. E. A. Ippolitova, D. G. Faustova, and V. I. Spitsyn. Translated from "Issledovaniya v Oblasti Khimii Urana."

The dissolution enthalpies of monouranates of all the alkali elements and calcium in HCl, were determined. The enthalpies of formation of monouranates of alkali elements and calcium were calculated. It was found that the enthalpies of formation of monouranates of alkali elements are nearly equal. The values of enthalpies of formation are largest in potassium and rubidium uranates. (auth)

15443 (ANL-Trans-33(p.173-5)) DETERMINATION OF TRUE THERMAL CAPACITIES OF URANATES OF ALKALI ELEMENTS AND CALCIUM. D. G. Faustova, E. A. Ippolitova, and V. I. Spitsyn. Translated from "Issledovaniya v Oblasti Khimii Urana."

The true thermal capacity of monouranates of all the alkali elements and calcium in the temperature range from 390–916°C was measured. It was found that the values of true thermal capacities of monouranates of alkali elements steadily increase with increasing temperature. No transformations were observed in the temperature range covered. (auth)

15444 (ANL-Trans-33(p.176-9)) ANHYDROUS CALCIUM URANATES. I. A. Bereznikova, E. A. Ippolitova, Yu. P. Simanov, and L. M. Kovba. Translated "Issledovaniya v Oblasti Khimii Urana."

Using the thermographic and x-ray diffraction methods, the composition of calcium uranates formed as a result of air calcination of $CaCO_3$ or CaO with uranium oxides (U_3O_8 or UO_3) was investigated. It was established that the formation of calcium monouranate from $CaCO_3$ and U_3O_8 occurs at 730–800°. The formation of calcium diuranate (900°) runs through the stage of monouranate (800°). At 1200°, a phase of composition $CaU_2O_{6.24}$ with a structure of the type $CaF_2 (\alpha = 5360 \pm 0.002)$ forms. Under the experimental conditions (900°), polyuranates with higher acidity than that of diuranates were not obtained. At 1200°, a phase of composition $(Ca_{0.25}U_{0.75})O_{2+x}$ with a structure of the type CaF_2 was produced. The x-ray diffraction pattern of calcium triorthouranate Ca_3UO_6 obtained in calcination of the proper mixture of $CaCO_3$ and U_3O_8 at 1000°, was indexed by presuming a rhombic cell with parameters: a = 5.72; b = 5.94; c = 8.27; Z = 2 (the rhombic distorted structure of cryolite type). When a mixture of Ca : U = 2 : 1 is calcined at 900°, Ca UO_4 and Ca_3UO_6 form; Ca_2UO_5 originates at 1200°. (auth)

15445 (ANL-Trans-33(p.180-5)) ANHYDROUS STRONTIUM URANATES. E. A. Ippolitova, I. A. Bereznikova, V. D. Kosynkin, Yu. P. Simanov, and L. M. Kovba. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the thermographic and x-ray diffraction methods, the composition of strontium uranates formed during the calcination of $SrCO_3$ with the hydrate of uranium peroxide in air, was determined. Two modifications of strontium monouranates were obtained: rhombohedral and rhombic. The parameters of their cells were determined: for the rhombic modification $SrUO_4$ a = 5.480; b = 7.956; c = 8.112; Z = 4; V/Z = 88.4; for the rhombohedral modification a = 3.893 ± 0.005; c = 18.30 ± 0.05; Z = 3; V/Z = 70.1. It was ascertained that strontium polyuranates produce only one phase of a composition $SrO \cdot 1.5 - 1.75\ UO_3$ which has a greatly distorted structure of the type CaF_2. Strontium orthouranate of a composition Sr_3UO_6 was obtained. The approximate parameters of its pseudocubic cell were determined: $a \approx b \approx c \approx 8.5$; $\alpha \approx \beta \approx \gamma \approx 90°$. (auth)

15446 (ANL-Trans-33(p.186-93)) INVESTIGATION OF THE COMPOSITION OF ANHYDROUS BARIUM URANATES. E. A. Ippolitova, I. A. Bereznikova, V. Ya. Leonidov, and L. M. Kovba. Translated from "Issledovaniya v Oblasti Khimii Urana."

Making use of the thermal and x-ray diffraction methods, the composition of barium uranates formed in heating barium carbonate with the hydrate of uranium peroxide, was determined. It was ascertained that the x-ray diffraction pattern in the calcination of the mixture in the ratio Ba : U = 1 : 2 referable to barium diuranate, is characterized by an individual set of lines. Barium diuranate may join more uranium and form a phase of a rough composition $BaO \cdot (2 + x)\ UO_3$, where x varies from 0.2 to 0.5. In decomposition of barium-uranyl acetate, two phases form: $BaO \cdot (2 + x)\ UO_3$ (in excess) and BaU_2O_7. In the calcination of various mixtures of $BaCO_3$ with the hydrate of uranium peroxide, the formation of uranates in ratio U : Ba > 2.5 was not observed. $BaO \cdot (2 + x)\ UO_3$ and U_3O_8 are the calcination products of these mixtures. (auth)

15447 (ANL-Trans-33(p.194-202)) INVESTIGATION OF THE REACTION PROCESS BETWEEN URANYL NITRATE AND HYDROXIDES OF CALCIUM, STRONTIUM, AND BARIUM. I. A. Bereznikova, E. A. Ippolitova, N. I.

Pechurova, V. P. Danilov, and N. S. Buchenkova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using potentiometric and conductometric titrations, the reaction process between uranyl nitrate and hydroxides of calcium, strontium, and barium was studied. It was determined that, regardless of the nature of the hydroxide, in adding 0.75, 1, 1.16, 1.25, 1.33, 1.5, and 2 moles of the hydroxide per mole of uranyl nitrate, the same points of inflection in the titration curves were observed. According to suppositions, this indicates the formation of the following compounds: $UO_2(NO_3)_2 \cdot 3UO_2(OH)_2$, $UO_2(OH)_2$, $Me^{II}U_6O_{19}$, $Me^{II}U_4O_{13}$, $Me^{II}U_3O_{10}$, $Me^{II}U_2O_7$, and $Me^{II}UO_4$. Besides this, a soluble basic salt $UO_2(OH)NO_3$ in ratio Me : U = 0.5 : 1 forms. (auth)

15448 (ANL-Trans-33(p.203-12)) INVESTIGATION OF THE COMPOSITION OF THE PRECIPITATES OF CALCIUM, STRONTIUM AND BARIUM URANATES FORMING AT VARIOUS pH IN THE SOLUTION. E. A. Ippolitova, I. A. Bereznikova, N. I. Pechurova, and V. P. Danilov. Translated from "Issledovaniya v Oblasti Khimii Urana."

The composition of calcium, strontium, and barium uranates produced at various pH in solution was investigated. Using the x-ray diffraction pattern, it was found that only slightly hydrolyzed monouranate and diuranate may be separated from solution. In air-calcination of the precipitates obtained at pH 9.5–6.6, uranoso-uranic-oxide-base solid solution forms. As a result of chemical analysis of the precipitated strontium uranates obtained at pH which correspond to the points of inflection in the potentiometric titration curves, the formation of mono-, di-, tri-, and hexauranates of strontium was established. The majority of them is greatly hydrolyzed. It was shown that the composition of precipitated uranates is dependent on the order as how the solutions of reagents are mixed. When the solution of uranyl nitrate is poured into the solution of alkali, orange, partly hydrolyzed monouranates (Sr) or diuranates (Ca,Ba) form; following addition of alkali to the solution of uranyl nitrate, more acid uranates form (the precipitates are yellow). The method of precipitating uranium as calcium uranate with the aid of alkali in the presence of calcium chloride was tested. Making use of the radioactive isotopes ^{45}Ca and ^{24}Na, it was determined that sodium hydroxide introduced into the reaction mixture initiates the formation of calcium uranate, but sodium ions are only adsorbed by the precipitate. It was found out that with calcium chloride present, the precipitation of uranium was more complete. (auth)

15449 (ANL-Trans-33(p.213-19)) INVESTIGATION OF CADMIUM URANATES PRODUCED IN REACTION BETWEEN URANOSO–URANIC OXIDE AND CADMIUM OXIDE. E. A. Ippolitova, G. P. Polunina, L. M. Kovba, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using thermal and x-ray diffraction methods, the composition of products produced in heating CdO and U_3O_8 taken in various ratios, was studied. The formation of cadmium orthouranate of the composition Cd_3UO_6, two modifications of a normal cadmium uranate, and cadmium diuranate, was discovered. The existence of a phase of variable composition $Cd_xU_{1-x}O_{3-y}$ ($x = 0.25 - 0.17$, $y \approx 2x$) formed in calcination (800°, ~10 hours) of tri-, tetra- and pentauranate mixtures of cadmium oxide with uranoso-uranic oxide, which crystallizes as orthorhombic system, was detected. Prolonged calcination (800°, ~30 hours) of the triuranate mixture produces a phase with monoclinic lattice. When polyuranate mixtures in ratio Cd : U < 1 : 5 were calcined, the presence of two phases U_3O_8 and $Cd_xU_{1-x}O_{3-y}$ ($x = 0.25 - 0.17$, $y \approx 2x$) was detected. In thermal decomposition of monouranate and orthouranate of cadmium, phases of variable composition $CdUO_{4-x}$ (925°) and $(U,Cd)O_{2-x}$ (1000°) formed. Based on the indexing of the Debye diffraction patterns, the cell types and parameters for Cd_3UO_6, α-$CdUO_4$ and for phases of variable composition $CdUO_{4-x}$, $Cd_xU_{1-x}O_{3-y}$, $(U,Cd)O_{2-x}$ were determined. Using Laue, vibration, and powder pattern methods in studying the single crystals β-$CdUO_4$, the type of the unit cell and its parameters were determined. (auth)

15450 (ANL-Trans-33(p.220-3)) INVESTIGATION OF THE REACTION PRODUCTS BETWEEN ZnO AND U_3O_8 G. P. Polunina, L. M. Kovba, and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using thermal and x-ray diffraction methods, the composition of the reaction products of ZnO and U_3O_8 taken in various ratios in the temperature range from 20–1000°, was ascertained. It was found out that under the present conditions, only triuranate of zinc ZnU_3O_{10} was produced. With the aid of Laue, vibration, and powder pattern methods, the cell type and parameters of the single crystal ZnU_3O_{10} were determined. (auth)

15451 (ANL-Trans-33(p.224-7)) ON THE REACTION PRODUCTS BETWEEN URANOSO–URANIC OXIDE AND MAGNESIUM OXIDE. G. P. Polunina, L. M. Kovba, and E. A. Ippolitova. Translated from "Issledovaniya v Oblasti Khimii Urana."

By means of the thermal and x-ray diffraction methods, the composition of products obtained in heating MgO with U_3O_8 taken in various ratios in the range from 20–1000°, was investigated. The formation of monouranate and triuranate of magnesium was confirmed. It was found that the formation of magnesium monouranate runs through the magnesium triuranate stage. Based on indexing of the Debye powder pattern of magnesium triuranate, the type and parameters of its cell were determined. Calcination of the mixtures of MgO and U_3O_8 in ratios Mg : U = 1 : 1, 1 : 2, and 1 : 3 at 1200° in air resulted in formation of the respective phases $MgUO_{3.86}$, $MgU_2O_{6.15}$, $MgU_3O_{9.09}$ which crystallized in the fluorite type; certain limits to the maximum content of oxygen in the phases of such a type are set up. (auth)

15452 (ANL-Trans-33(p.228-37)) ON THE PROBLEM OF FORMATION OF TETRAVALENT URANIUM SILICATES IN GLASS. D. N. Kravtsev, E. A. Ippolitova, and Yu. P. Simanov. Translated from "Issledovaniya v Oblast Khimii Urana."

Using the x-ray diffraction method, the systems $UO_2-SiO_2-Na_2SiO_3$, $UO_2-SiO_2-K_2SiO_3$, $UO_2-Li_2Si_2O_5$, and UO_2-SiO_2 were investigated. It was found that in these systems (under the experimental conditions) neither silicates of tetravalent uranium nor mixed silicates of tetravalent uranium and alkali metal form. The formation of clear, green glass is associated with the dissolution of uranium dioxide in the melt of alkali disilicate. The green color of the glass is laid on by the U^{+4} ion. It was found that the solubility of UO_2 in lithium and sodium disilicate melts is limited and the solubility is absent in potassium disilicate melt. The solubility of UO_2 in silicate melts increases with increasing temperature. In annealing the glass, the solution disintegrates and UO_2 precipitates. Uranium dioxide renders a stabilizing effect on the crystallization of the glass. In the melts of alkali metasilicates, which do not contain excessive SiO_2, UO_2 is insoluble. Uranium dioxide does not react with silicon dioxide at temperatures from 1750–1800°, nor in a medium of molten NaCl at lower temperatures. The double-decomposition reactions between tetravalent uranium salts and alkali silicates do not lead to formation of tetravalent uranium silicates. (auth)

15453 (ANL-Trans-33(p.238-44)) INVESTIGATION OF REACTION BETWEEN URANOSO–URANIC OXIDE AND ALKALI SILICATES IN THE PRESENCE OF ATMOSPHERIC OXYGEN. V. I. Spitsyn, E. A. Ippolitova, D. N. Kravtsev, and Yu. P. Simanov. Translated from "Issledovaniya v Oblasti Khimii Urana."

The system alkali silicate–U_3O_8–O_2 was investigated. It was found that at temperatures from 800–950° in the system $Na_2SiO_3-U_3O_8-O_2$ in the ratio U : Na_2SiO_3 = 1 : 20 – 3 : 1 and in the system $Na_2Si_2O_5-U_3O_8-O_2$ in the ratio U : $Na_2Si_2O_5$ = 1 : 5 – 3 : 1, sodium diuranate forms. In the system $K_2Si_2O_5-U_3O_8-O_2$ in the ratio U : $K_2Si_2O_5$ = 1 : 5 – 1 : 1, potassium diuranate forms, but in ratio 2 : 1 and 3 : 1, potassium triuranate is produced. In the ratios covered, one failed to observe the formation of uranyl silicate or mixed uranyl silicate and alkali metal in any of these systems. (auth)

15454 (ANL-Trans-33(p.245-59)) INVESTIGATION OF THE OXIDATION PROCESS OF URANIUM DISULFIDE.

E. A. Ippolitova, K. M. Dunaeva, and N. D. Mitrofanova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Applying the chemical, x-ray diffraction, and thermal analytical methods, the oxidizing process of uranium disulfide in oxygen current saturated with water vapor at room temperature was investigated. It was determined that at 100° the α-form of uranium disulfide changes to a more reactive β-form, and then a slow oxidation of disulfide associated with insignificant formation of uranyl sulfate and evolution of sulfur dioxide begins. Beginning with 250°, the formation of uranium dioxide was observed. The production of uranyl sulfate is highest at 400°. Uranoso-uranic oxide is the end product of the oxidation of uranium disulfide (700–800°). It was made clear that the formation of uranium dioxide results from the following parallel reactions: $US_2 + 3UO_2SO_4 = 4UO_2 + 5SO_2$, and $US_2 + SO_2 = UO_2 + 3S$. The degree of passage of uranium and sulfur from oxidation products into solution was investigated. It was found that the largest quantity of uranium (31% of its content in the preparation) and sulfur (100%) from the oxidation product of uranium disulfide passes into solution at 400°. (auth)

15455 (ANL-Trans-33(p.260-72)) INVESTIGATION OF THE OXIDATION PROCESS OF URANIUM OXYSULFIDE. K. M. Dunaeva, E. A. Ippolitova, and G. D. Khrustaleva. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using the chemical, x-ray diffraction, and thermal analytical methods, the oxidation process of uranium oxysulfide in oxygen current saturated with water vapor at room temperature, was investigated. It was determined that the oxidation process of uranium oxysulfide begins at 300° and is associated with the formation of the roentgenoamorphous uranyl sulfate. The optimum temperature in the transition of uranium oxysulfide to uranyl sulfate is 450°. At higher temperatures, the formation of uranoso-uranic oxide is observed. In leaching the oxidation products of uranium oxysulfide, it was discovered that the quantity of uranium passed into the solution of the oxidation products was largest (47% of its content in the solution) at 450°. Uranium oxysulfide of the composition UOS may be obtained by reducing uranoso-uranic oxide with hydrogen sulfide in a graphite boat not only at 1000–1100°, but also in the temperature range from 900–950°. The degree of transition of uranium oxysulfide to uranyl sulfate is dependent on conditions under which it is produced. The UOS preparations obtained from U_3O_8 at 900–950°, as well as from uranium trioxide at temperatures from 1050–1100°, manifest almost complete oxidation into uranyl sulfate when subjected to moist oxygen. (auth)

15456 (ANL-Trans-33(p.273-9)) URANYL PHOSPHATES. V. I. Spitsyn, I. A. Murav'eva, O. G. Nemkova, and V. G. Gulia. Translated from "Issledovaniya v Oblasti Khimii Urana."

From 0.001 m and less concentrated acid solutions (pH 2.4) of uranyl nitrate using the solution of sodium phosphate, the neutral uranyl phosphate $(UO_2)_3(PO_4)_2 \cdot 3H_2O$ was precipitated. Sodium phosphate Na_2HPO_4 may be used to precipitate hexavalent uranyl from 0.001 molar uranyl nitrate solutions provided pH of the solution does not exceed 2.4. (auth)

15457 (ANL-Trans-33(p.280-9)) DOUBLE URANYL PHOSPHATES. I. A. Murav'eva, O. G. Nemkova, R. P. Cherkasova, and A. S. Orlova. Translated from "Issledovaniya v Oblasti Khimii Urana."

The double salt of sodium-uranyl phosphate may be precipitated from acid solutions of uranyl salts using sodium hydrophosphate if the concentration of the solutions does not exceed 0.005 mole. The double salt of sodium-uranyl phosphate may be precipitated from the solutions of uranyl salts with calcium, strontium, and barium salts present; it cannot be precipitated in the presence of copper salts. (auth)

15458 (ANL-Trans-33(p.290-2)) LITHIUM–URANYL PHOSPHATE. I. A. Murav'eva, O. G. Nemkova, and Yu. V. Orlova. Translated from "Issledovaniya v Oblasti Khimii Urana."

The conditions favorable for producing lithium-uranyl phosphate were studied, and the composition of this salt and some physicochemical values were determined. (auth)

15459 (ANL-Trans-33(p.293-8)) REACTION BETWEEN SODIUM HYPOPHOSPHITE AND HEXAVALENT URANIUM COMPOUNDS. V. I. Spitsyn, V. G. Gulia, O. G. Nemkova, and M. S. Golubkova. Translated from "Issledovaniya v Oblasti Khimii Urana."

The conditions favorable for producing uranyl hypophosphites and some properties of these salts were investigated. It was shown that in prolonged irradiation of the mixture of solutions of sodium hypophosphite and uranyl sulfate, complete reduction of hexavalent uranium to tetravalent is possible. The effect of pH of the medium and concentration of hypophosphite on the precipitation of uranium was investigated. (auth)

15460 (ANL-Trans-33(p.299-304)) INVESTIGATION OF THE POSSIBILITY OF USING LOW-VALENCE PHOSPHORUS COMPOUNDS AS REDUCING AND PRECIPITATING AGENTS OF URANIUM. V. G. Gulia, O. G. Nemkova, and E. V. Vedencheva. Translated from "Issledovaniya v Oblasti Khimii Urana."

The solution obtained in a slow oxidation of white phosphorus in humid air may be used as reducing agent for hexavalent uranium. It was found that the precipitation percentage of uranium in a form of phosphite by a phosphorus-bearing mixture obtained from the solution of hexavalent uranium, is highest at pH 1. (auth)

15461 (ANL-Trans-33(p.305-14)) INVESTIGATION OF THE COMPOSITION OF PRECIPITATED URANIUM VANADATES. V. G. Gulia, O. G. Nemkova, V. I. Belomestnykh, and F. S. Dukhovich. Translated from "Issledovaniya v Oblasti Khimii Urana."

It was determined that the reaction between solutions of uranyl nitrate and solutions of metavanadates results in the formation of difficultly soluble double uranium vanadates. A series of difficultly soluble uranium vanadates was also separated. It was found that the composition of the precipitated uranium vanadates is dependent on concentration and pH of the initial solutions, and time these salts were in contact with the mother liquor. (auth)

15462 (ANL-Trans-33(p.315-22)) PRECIPITATION OF URANIUM VANADATES IN THE PRESENCE OF SOME METAL SALTS. V. G. Gulia and O. G. Nemkova. Translated from "Issledovaniya v Oblasti Khimii Urana."

A series of difficultly soluble uranium vanadates was separated, and some of their properties were studied. It was determined that polyvanadates greatly hydrolyze in aqueous solutions; the conditions under which the composition of these salts does not change, were studied. The uranium content in saturated aqueous solutions of uranium vanadates and in solutions of some salts was determined. (auth)

15463 (ANL-Trans-33(p.323-5)) INVESTIGATION OF THE REACTION BETWEEN AMMONIUM–URANIUM VANADATE AND VANADIUM PENTOXIDE. V. G. Gulia, O. G. Nemkova, and F. S. Dukhovich. Translated from "Issledovaniya v Oblasti Khimii Urana."

The possibility of obtaining condensed uranyl vanadates was studied by reacting ammonium uranyl vanadate with V_2O_5 in solution. The ratio of U to V was set at 1:2 and 1:3, and the extent of reaction was determined over a period of 1 to 2 months using x-ray and electron diffraction methods. The results clearly indicate the formation of products with U/V ratios of 1:2 and 1:3. (D.L.C.)

15464 (ANL-Trans-33(p.326-38)) INVESTIGATION OF THE REACTION BETWEEN URANIUM AND URANYL PHOSPHATES AND CALCIUM OXIDE AT HIGH TEMPERATURES. Yu. P. Muromskii, Yu. P. Simanov, and O. G. Nemkova. Translated from "Issledovaniya v Oblasti Khimii Urana."

In an atmosphere of inert gas, the reaction $U_3(PO_4)_4 + 6CaO \rightarrow 3UO_2 + 2Ca_3(PO_4)_2$ and in air, the reaction $(UO_2)_3(PO_4)_2 + 3CaO \rightarrow U_3O_8 + Ca_3(PO_4)_2 + \frac{1}{2}O_2$ and $(UO_2)_3(PO_4)_2 + 6CaO \rightarrow 3CaUO_4 + Ca_3(PO_4)_2$, were investigated by using the x-ray diffraction and chemical methods.

Their irreversibility in the temperature range from 400–1000° was proved. (auth)

15465 (ANL-Trans-33(p.339-49)) INVESTIGATION OF THE REACTION BETWEEN CaO, V_2O_5 AND U_3O_8 IN THE SOLID PHASE. G. I. Khlebnikov, Yu. P. Simanov, and O. G. Nemkova. Translated from "Issledovaniya v Oblasti Khimii Urana."

Using thermal, x-ray diffraction, and crystallooptical analytical methods, the following reactions were investigated: $CaCO_3 + V_2O_5 \rightarrow Ca(VO_3)_2 + CO_2$; $CaO + V_2O_5 \rightarrow Ca(VO_3)_2$; $CaCO_3 + 2V_2O_5 \rightarrow Ca(VO_3)_2 + V_2O_5$; and $2CaCO_3 + V_2O_5 \rightarrow Ca_2V_2O_7 + CO_2$. Based upon the thermal and x-ray diffraction analytical methods, the following reactions in air were studied: $3Ca(VO_3)_2 + 2U_3O_8 + \frac{1}{2}O_2 \rightarrow 3CaUO_2V_2O_7 + U_3O_8$; $3Ca_2V_2O_7 + U_3O_8 + \frac{1}{2}O_2 \rightarrow Ca_2UO_2(VO_4)_2$; and $3Ca(VO_3)_2 + U_3O_8 + \frac{1}{2}O_2 \rightarrow 3CaUO_2V_2O_7$. $CaUO_2V_2O_7$ was synthesized. A number of interplanar distances (d) of the crystal lattices of vanadates $Ca(VO_3)_2$, $Ca_2V_2O_7$, and $CaUO_2V_2O_7$ synthesized by the authors, was determined. (auth)

15466 (LA-tr-65-2) HYDRIDES OF LANTHANUM, NEODYMIUM, YTTRIUM AND SCANDIUM. M. E. Kost and V. I. Mikheeva. Translated by Helen J. Chick and C. P. Kempter (Los Alamos Scientific Lab., N. Mex.), from Redkozem. Elementy, 5-7(1963). 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

Hydrides of the rare earth elements were obtained by hydrogenation in vacuum. La, Nd, and Y were found to react with hydrogen at room temperature, while Sc reacts only with heating. The maximum saturation by hydrogen corresponds to the formulas LaH_3, $NdH_{2.4}$, YH_2, and $ScH_{1.7}$. The chemical differences of the hydrides are discussed briefly, and their thermal stability was studied. (D.L.C.)

15467 (LA-tr-65-3) EQUILIBRIUM IN THE SYSTEM GRAPHITE–HYDROGEN AT HIGH TEMPERATURES AND ELEVATED PRESSURES. Z. V. Ievleva. Translated by Helen Chick and N. H. Krikorian (Los Alamos Scientific Lab., N. Mex.), from Zhur. Fiz. Khim., 38: 2380-85(1964). 13p. Dep.(mn); $1.00(cy) 1(mn) CFSTI $1.60(fs), $0.80 (mf) JCL.

An experimental study was made of the equilibrium compositions (methane and unsaturates) in the system graphite–hydrogen at 1800 to 2600°K and pressures up to 45 bars. The results agree with thermodynamic calculations, although some systematic differences are evident. (D.L.C.)

15468 PHASE ANALYSIS STUDIES ON NIOBIUM OXIDE FLUORIDES. Sten Andersson (Research Inst. of National Defence, Stockholm and Univ. of Stockholm) and Anders Astroem. Acta Chem. Scand., 18: 2233-6(1964).

Two phases of intermediate compositions, Nb_3O_7F and $Nb_5O_{12}F$, were synthesized in the Nb_2O_5–NbO_2F system in the temperature ranged from 500 to 800°C. The two oxide fluorides were studied by means of x-ray diffraction techniques. The presence of fluorine in "Specpure" niobium pentoxide is discussed. (auth)

15469 THE CRYSTAL STRUCTURE OF Nb_3O_7F. Sten Andersson (Research Inst. of National Defence, Stockholm and Univ. of Stockholm). Acta Chem. Scand., 18: 2339-44 (1964).

The oxide fluoride Nb_3O_7F was found in "Specpure" niobium pentoxide. The compound was then synthesized by the reaction of α-Nb_2O_5 and NbO_2F. Its crystal structure was determined, using single-crystal methods. The space group is Cmmm, with the unit-cell dimensions: a = 20.67; b = 3.833; and c = 3.927 Å. The structure consists of blocks of the ReO_3 structure type, which are fused together by means of octahedra sharing edges. The blocks are infinite in the b- and c-directions and limited to three octahedra in the a-direction. A hypothetical structure of this type was earlier described by Wadsley as being the end member of a homologous series of mixed oxides of titanium and niobium, following the general formula $M_{3n}O_{8n-3}$. (auth)

15470 A CRYSTAL HYDRATE $UF_4 \cdot \frac{4}{3}H_2O$. Yu. V. Gagarinskii, E. I. Khanaev, N. P. Galkin, L. A. Anan'eva, and S. P. Gabuda. At. Energ. (USSR), 18: 40-5(Jan. 1965). (In Russian)

A new hydrated form of uranium tetrafluoride $UF_4 \cdot \frac{4}{3}H_2O$ and its dehydrated products were studied by infrared spectroscopy, nuclear magnetic resonance, thermographic, refractometric, and x-ray analyses. The studies revealed a new uranium tetrafluoride crystal hydrate of monoclinic structure. The crystal hydrate retains water by a hydrogen bond with fluorine. The water molecular bond is divided into three groups, according to the free peaks in the absorption bands of the valence and deformation fluctuations in the H—O bond. During dehydration the structure of the crystal hydrate was retained up to $UF_4 \cdot H_2O$; further dehydration (to 0.5 H_2O) induced a phase transformation followed by a structural change with a crystal lattice similar to a cubic structure crystal hydrate (tr-auth)

15471 A RELATIVE VOLATILITY OF HTO SOLUTIONS IN H_2O. Ya. D. Zel'venskii, V. A. Shalygin, V. S. Tatarinskii, and D. A. Nikolaev. At. Energ. (USSR), 18: 56-8(Jan. 1965). (In Russian)

The relative volatility of HTO in H_2O solutions at 38 to 100°C was determined by a simple distillation method and Rayleigh equations. The results are described by a log $\alpha = (38.80/T) - 0.0935$. The data obtained were similar to the data on the separation coefficient calculated by M. M. Popov et al. (Atomnaya Energiya 8: 420(1960)) on the basis of T_2O vapor pressure. (tr-auth)

15472 NEUTRON DIFFRACTION STUDY OF DEUTERATED OXALIC ACID DIHYDRATE, $(COOD_2) \cdot 2D_2O$. Fujiko Fukushima, Hitoshi Iwasaki, Yoshihiko Saito, Shoichi Sato, and Sadao Hoshino (Tokyo Univ.). Bull. Chem. Soc. Japan, 38: 151-2(Jan. 1965).

A neutron diffraction study of deuterated oxalic acid dihydrate $(COOD_2) \cdot 2D_2O$ was undertaken in order to determine the deuteron positions and to investigate the difference between the hydrogen bonds in it and regular oxalic acid dihydrate. Data are presented in tables and figures. (M.C.G.)

15473 STUDY OF IONIC SPECIES OF PROTACTINIUM IN AQUEOUS SOLUTION. Francoise Boulanger and Robert Guillaumont (Universite, Paris). Bull. Soc. Chim. France, No. 11, 3031-2(Nov. 1964). (In French)

Variation of the distribution coefficient q of Pa^{5+} at 25°C between hydrochloric acid aqueous solutions and benzene solutions of 2-thenoyltrifluoracetone was studied as a function of the concentration of the chelating agent in the organic phase for different acidities, and the results are reported. This study is within the framework of a more complete study of the behavior of pentavalent protactinium in hydrochloric acid medium. (tr-auth)

15474 A PULSED ION SOURCE FOR THE STUDY OF UNIMOLECULAR AND BIMOLECULAR REACTIONS OF GAS-PHASE IONS. T. W. Shannon, F. Meyer, and A. G. Harrison (Univ. of Toronto). Can. J. Chem., 43: 159-74 (Jan. 1965).

A pulsed ion source was constructed for use with a magnetic-deflection mass spectrometer. With this source the time between ion formation and withdrawal for analysis can be controlled and varied in a known manner. The design and operating characteristics of the source are discussed and a technique is described for the measurement of ion withdrawal times using the pulsing technique. The rate constant for the ion molecule reaction $CH_4^+ + CH_4 \rightarrow CH_5^+ + CH_3$ was determined for the reaction of thermal energy ions using reaction time as the experimental variable. The equivalent reactions in the deuteriomethanes were also studied. Preliminary results obtained in the study of the unimolecular fragmentation of the cyclohexadiene, toluene, and spiroheptadiene parent ions are presented. (auth)

15475 STUDY BY X-RAY DIFFRACTION STUDY OF THIN LAYERS OF LANTHANUM FLUORIDE. Antoinette Bourg and Dhetty Talbot (Universite de Paris, Marseille and CNRS, Marseille). Compt. Rend., 259: 4608-11 (Dec. 21, 1964). (In French)

Thin layers of lanthanum fluoride were studied by x-ray

diffraction. The results obtained showed that the thin layers are crystallized and that the structure of these layers depends on the temperature of the support during projection. (tr-auth)

15476 MAGNETIC SUSCEPTIBILITY OF THE TRIFLUORIDE AND BETA-PENTAFLUORIDE OF URANIUM. Nguyen-Nghi, Hubert Marquet-Ellis, and Albert-Jose Dianoux (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 259: 4683-4(Dec. 21, 1964). (In French)

The magnetic susceptibilities of UF_3 and β-UF_5 were measured at temperatures higher than 86°K. The Curie-Weiss law was verified above 128°K. For UF_3, the magnetic moment is $\mu = 3.50 \pm 0.017$ μ_B/ion uranium and the Weiss constant $\Delta = 32.2 \pm 3.1$°K. For β-UF_5, $\mu = 2.24 \pm 0.01$ μ_B/ion uranium and $\Delta = 75.4 \pm 2.1$°K. (tr-auth)

15477 CRYOSCOPIC DETERMINATION OF THE STRUCTURE IN SOLUTION OF COMPLEX CARBONATES OF RARE EARTHS. Francine Fromage and Jacques Faucherre (Faculte des Sciences, Reims, France). Compt. Rend., 260: 572-3(Jan. 11, 1965). (In French)

It is shown with the aid of cryoscopic measurements that the complex carbonates of erbium, thulium, and ytterbium correspond to the general formula $[M(CO_3)_4]^{5-}$. (tr-auth)

15478 PHOTOCHEMICAL OXIDATION OF FORMALDEHYDE BY URANYL IONS [U(VI)] IN AQUEOUS SOLUTION. K. Venkata Rao and M. Santappa (Univ. of Madras). Current Sci. (India), 33: 709-10(Dec. 5, 1964).

Oxidation of formaldehyde (0.02 to 0.2M) by uranyl perchlorate(0.01 to 0.05M) in perchloric acid medium by light of $\lambda = 4350$Å under conditions of constant temperature (35 ± 0.01°C), ionic strength ($\mu = 0.5$), and pH(<2) was carried out. Data are presented in graphs. The dark reaction between (UVI) and formaldehyde was totally absent at 35 to 80°C. The under-aerated system on irradiation produced no U(IV). There was a direct proportionality between rate and light intensity and rate and light absorption factor, and an inverse proportionality between rate and (H^+). The rate was independent of temperature. The formation of a transient photosensitive cluster is postulated. (M.C.G.)

15479 EQUILIBRIUM IN AQUEOUS SOLUTIONS OF URANYL THIOCYANATE COMPLEXES. V. P. Vasil'ev and P. S. Mukhina (Ivanovo Inst. of Chemistry and Tech., USSR). Izv. Vysshikh Uchebn., Zavedenii, Khim. i Khim. Tekhnol., 7: 711-14(1964). (In Russian)

Equilibrium and optical density of uranyl thiocyanate complexes in aqueous solutions were studied for a wide range of thiocyanate concentrations. The stability constants and molar extinction coefficients for uranyl thiocyanate complexes at 2.5 to 4 ion force and 22 to 23°C were determined. The thermodynamic instability constants of uranyl thiocyanate complexes were found and magnitudes of their standard isobar potentials in aqueous solutions were calculated. (R.V.J.)

15480 A MULTIPLE BOND BETWEEN TECHNETIUM ATOMS IN AN OCTACHLORODITECHNETATE ION. F. A. Cotton and W. K. Bratton (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 87: 921(Feb. 20, 1965).

An x-ray diffraction study was made of the compound $(NH_4)_3Tc_2Cl_8 \cdot 2H_2O$. The unit cell has trigonal symmetry with the dimensions $a = 13.03 \pm 0.02$ and $c = 8.40 \pm 0.01$Å. The space group was found to be $P3_121$. The characteristic feature of the structure was found to be the occurrence of Tc_2Cl_8 groups. Their virtual symmetry was D_{4h}, although, crystallographically, they possess only a single C_2 axis bisecting the Tc-Tc bond. (M.C.G.)

15481 DISTRIBUTION OF UO_2 PARTICLES PREPARED FROM VARIOUSLY CALCINATED U_3O_8 INVESTIGATED BY SEDIMENTATION ANALYSIS. P. Imris, H. Landspersky, and M. Voboril (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). J. Appl. Chem. (London), 15: 48-56(Jan. 1965).

The size distribution of UO_2 particles with a specific surface area of 1 to 6 m^2/g, prepared from U_3O_8 by reduction in hydrogen and calcined at temperatures between 610 and 1000°C, was determined. Of the U_3O_8 and UO_2, 90 wt % was within the particle size range from 4 to 90 μ. The narrowest spectrum, 4 to 56 μ, was found in the product of calcination at 700°C, which was, in comparison with all the other samples, easiest to sinter. After being pressed at 2.5 tons/cm^2 and sintered at 1600°C the pellets attained a density of 96% theoretical. The work was carried out to find a connection between the physical, physico-chemical, and sintering properties of UO_2. (auth)

15482 MAGNETIZATION OF POLYCRYSTALLINE EuS AS DETERMINED BY THE PYROMAGNETIC METHOD. B. E. Argyle (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 36: 679-83 (Mar. 1965).

Measurements of magnetization of polycrystalline EuS powder are obtained by the pyromagnetic method between 4.2 and 60°K in fixed applied fields ranging from 4 to 14 kgauss. For fields sufficient to saturate ($H_0 \geq 12$ kgauss), the data, as analyzed by Weiss molecular field theory with a graphical technique, specify $T_c = 16.5 \pm 0.2$°K, in good agreement with the specific heat anomaly at 16.2°K. The observed behavior of the approach to saturation suggests a preferred choice of mechanisms for the origin of the large saturation field. (auth)

15483 TWO-CENTER WAVEFUNCTIONS FOR ABH_n SYSTEMS. ILLUSTRATIVE CALCULATIONS ON H_2^+ AND H_3. James R. Hoyland (Argonne National Lab., Ill.). J. Chem. Phys., 41: 1370-6(Sept. 1, 1964).

Two-center wavefunctions are constructed for linear H_3^+ and H_3 and for triangular (equilateral) H_3^+ using a basis set of generalized elliptical orbitals. The results are encouraging, and possible future applications of the method are discussed. (auth)

15484 QUANTUM CELL MODEL FOR SOLIDS AT LOW TEMPERATURE. Robert D. Reed (Ling-Temco-Vought, Inc., Dallas), Douglas Henderson, and Ru-Yong Chen. J. Chem. Phys., 42: 1884-6(Mar. 15, 1965).

The cell model was widely applied to classical liquids and was recently applied to quantum liquids. In the cell model it is assumed that each molecule moves independently in a cell formed by the neighboring molecules. This assumption is considered more reasonable for the solid state than for the liquid state. The cell model was therefore applied to solids at low temperatures. Results are reported for Ar, H_2, D_2, and ^4He. Agreement with experiment is good. (auth)

15485 COLLISIONAL-RADIATIVE RECOMBINATION OF He_2^+ INTO DISSOCIATIVE STATES. W. W. Robertson (Univ. of Texas, Austin). J. Chem. Phys., 42: 2064-70 (Mar. 15, 1965).

Spectroscopic investigation of a flowing helium afterglow revealed the presence of strong 10,830-Å atomic helium emission corresponding to the $2^3P \rightarrow 2^3S$ transition, which could be quenched by the application of a weak microwave field to the afterglow. An examination of the axial variation and pressure dependence of the concentration of 2^3P atoms established that it resulted primarily from the ion-electron recombination of He_2^+, rather than He^+, at the higher pressures examined. An extension of the theory of collisional-radiative recombination of molecular ions to include dissociating states is postulated to explain these observations. (auth)

15486 RECTANGULAR APPROXIMATION FOR CONCENTRATION-DEPENDENT SEDIMENTATION IN THE ULTRACENTRIFUGE. George H. Weiss and David A. Yphantis (Rockefeller Inst., New York). J. Chem. Phys., 42: 2117-23(Mar. 15, 1965).

An exact solution to the rectangular approximation of the Lamm equation where $s = s_0(1 - kc)$ was derived. Properties of the solution were examined for approach to equilibrium and for velocity sedimentation. (auth)

15487 STUDY OF SEPARATED ELECTRON PAIRS IN THE LiH MOLECULE. Darrell D. Ebbing and Richard C. Henderson (Wayne State Univ., Detroit). J. Chem. Phys., 42: 2225-31(Mar. 15, 1965).

The separated-pair model was applied to the ground state

of the LiH molecule in an effort to estimate the inherent accuracy of this model, and to investigate a method for computing accurate pair functions. The procedure employs direct calculation with natural orbitals and was to be rapidly convergent if molecular orbitals were used as first guess in the iteration. The energy for seven σ orbitals was only slightly higher than the corresponding 41-term MO–CI function. A detailed comparison of the two functions is given. (auth)

15488 VIBRATIONAL SPECTRA AND VALENCE FORCE CONSTANTS OF THE SQUARE-PYRAMIDAL MOLECULES—$XeOF_4$, IF_5, BrF_5, AND ClF_5. G. M. Begun (Oak Ridge National Lab., Tenn.), W. H. Fletcher, and D. F. Smith. J. Chem. Phys., 42: 2236-? (Mar. 15, 1965). (ORNL-P-751)

The infrared and Raman spectra of $XeOF_4$, IF_5, BrF_5, and ClF_5 were recorded. The data were tabulated and assignments of the fundamental vibration and combination frequencies made on the basis of a square-pyramidal structure for these molecules. Valence force constants, based on estimated molecular parameters, were calculated for these molecules. Comparisons between the different members of the series showed that the bonding in $XeOF_4$ is remarkably similar to that in the interhalogen compounds. (auth)

15489 MASS SPECTRUM OF YTTRIUM CHLORIDE VAPOR. John D. McKinley (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 2245-6(Mar. 15, 1965).

Mass spectrometric measurements were made of the vapor effusing from a cell containing anhydrous yttrium chloride. Arrhenius plots of ion-current data are presented. No ions containing more than two yttrium atoms were observed. It appeared, therefore, that there are two important vapor species, YCl_3 and Y_2Cl_6, and that the dimer makes a negligible contribution to the monomeric ion current. It was concluded that YCl_3^+ is not a significant volatile product of the surface reaction at low temperature and represents not more than 5% of the total product at high temperatures. (M.C.G.)

15490 THE INFRARED SPECTRA OF THE ADSORBED PHASE ON TANTALUM OXIDE FILMS. F. Vratny (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 112: 289-94(Mar. 1965).

An investigation of the adsorbed phase on anodic and thermally grown tantalum oxide on sputtered tantalum was carried out using infrared reflectance and transmission spectral techniques. After exposure to air, it was possible to identify water, carbon dioxide, and hydrocarbon residues. Both the water and carbon dioxide were removed on evacuation and heating while the hydrocarbon residues were retained by the sample. It is proposed that the hydrocarbon residues occur as a result of gettering processes in the residual gases during sputtering of the original tantalum film, or by incorporation of the organic electrolyte used for anodizing. (auth)

15491 EFFECT OF AMBIENTS AND CONTACT AREA ON THE ASYMMETRIC CONDUCTION OF ANODIC TANTALUM OXIDE FILMS. N. Schwartz and M. Gresh (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 112: 295-300(Mar. 1965).

The effects of moisture and metallic contact area on the asymmetry properties of anodic tantalum oxide films, approximately 2400 Å thick, were investigated. Moisture was reversibly desorbed and adsorbed by vacuum baking followed by exposure at 50 to 85% relative humidity. The cathodic currents were not affected significantly by this cycle, while the anodic leakage and charging current could be changed by factors of 10^6 and 10^2, respectively. The contact area experiment confirmed previous results that the asymmetry is due to local inhomogeneities in the oxide film, since nonpolar characteristics, in the absence or presence of moisture could be obtained with a contact area of less than 0.01 mm^2. This result indicated that the moisture effect is associated with defects in the oxide film. The oxide film could thus be considered as a normal dielectric with high symmetrical anodic and cathodic breakdown voltages. Distributed on the average of 0.1 mm apart throughout the film were heterogeneities of an unknown nature, which caused a symmetrical but lower breakdown than the rest of the oxide. The asymmetry resulted from an increase in the anodic breakdown at these distinct sites due to the presence of water. (auth)

15492 PERMEATION OF 100 VOLT ISOLATED ANODIC ZIRCONIUM OXIDE FILMS BY POTASSIUM NITRATE. A. H. Mitchell (Frankford Arsenal, Philadelphia) and R. E. Salomon. J. Electrochem. Soc., 112: 361-2 (Mar. 1965).

Studies were made of the permeation of zirconium oxide films by solutions of potassium nitrate. Data on effects of KNO_3 concentration and temperature are presented. It was concluded that, in the films studied, permeation occurred through a network of small interstices where the activation process may be adsorption and desorption of ions on interstice walls. (M.C.G.)

15493 STUDIES IN THE CHEMISTRY OF METAL IODIDES. PART I. THERMAL DECOMPOSITION OF STRONTIUM IODIDE. E. B. Mirza and M. D. Karkhanavala (Atomic Energy Establishment, Trombay, India). J. Indian Chem. Soc., 41: 697-700(Oct. 1964).

Data obtained by thermogravimetric analysis of anhydrous and hexahydrated strontium iodide and by differential thermal analysis of $SrI_2 \cdot 6H_2O$ are reported. (auth)

15494 A MÖSSBAUER STUDY OF FERRIC OXYHYDROXIDE. M. J. Rossiter and A. E. M. Hodgson (Dept. of Scientific and Industrial Research, Wantage, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 63-71(Jan. 1965).

The Mössbauer absorption spectra of α-, β-, γ-, and δ-FeOOH were examined at room temperature and at 77°K. The isomer shift for the four forms was shown to be in the range characteristic of the Fe^{3+} ion. The spectra of β- and γ-FeOOH at room temperature showed two closely-spaced peaks, which indicated a small quadrupole interaction of 2 to 3 Mc/sec. The α-, β-, and δ-FeOOH gave "six-finger" spectra at 77°K confirming the existence of magnetic interaction in these oxides. Comparison of the temperature variation of the β-FeOOH spectrum with existing susceptibility data suggested that two types of negative exchange interaction occur in this oxide and possibly also in α-FeOOH. (auth)

15495 X-RAY POWDER CRYSTALLOGRAPHIC DATA ON PLUTONIUM AND OTHER OXALATES. I. THE OXALATES OF PLUTONIUM(III) AND PLUTONIUM(VI) AND THEIR ISOMORPHS. I. L. Jenkins, F. H. Moore, and M. J. Waterman (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 77-80(Jan. 1965).

The isomorphous oxalates of lanthanum(III), neodymium (III), gadolinium(III), and plutonium(III) were prepared and x-ray powder data and the unit cell parameters are given. Data are also given for plutonium(VI) oxalate and its isomorph uranium(VI) oxalate. (auth)

15496 X-RAY POWDER CRYSTALLOGRAPHIC DATA ON PLUTONIUM AND OTHER OXALATES. II. PLUTONIUM(IV) OXALATE DIHYDRATE, URANIUM(IV) OXALATE HEXAHYDRATE, URANIUM(IV) OXALATE DIHYDRATE AND THORIUM OXALATE DIHYDRATE. I. L. Jenkins, F. H. Moore, and M. J. Waterman (Atomic Energy Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 81-7(Jan. 1965).

Two series of isomorphous oxalates of plutonium(IV), uranium(IV), and thorium namely, the hexahydrates and dihydrates, were prepared; an acetone complex of Pu $(C_2O_4)_2 \cdot 2H_2O$ was also prepared. The x-ray powder data and cell parameters are given. (auth)

15497 ORGANIC COMPOUNDS OF LANTHANIDE ELEMENTS. III. ALCOHOLATES OF LANTHANUM AND CERIUM(III) CHLORIDES. S. N. Misra, and T. N. Misra, and R. C. Mehrotra (Univ. of Rajasthan, Jaipur, India). J. Inorg. Nucl. Chem., 27: 105-13(Jan. 1965).

The reactions of alcohols (methanol, ethanol, propanols, butanols, etc.) with anhydrous lanthanum and cerium(III)

chlorides were investigated and a large number of new compounds with the general formula $MCl_3 \cdot 3ROH$ were isolated. When lanthanum and cerium(III) chloride monohydrates were allowed to react with alcohols, dialcoholates with the formula $MCl_3 \cdot H_2O \cdot 2ROH$ were isolated. The synthesis of higher alcoholates from the lower derivatives was also successfully achieved by the use of alcohol interchange technique. Some physico-chemical properties (pyrolysis, molecular weight, conductivity, and spectra) of these alcoholate derivatives were also studied. (auth)

15498 2,2′-DIPYRIDYL COMPLEXES OF RARE EARTHS. II. REFLECTION SPECTRA OF Nd(III)-BIS-(2,2′-DIPYRIDYL) AND Nd(III)-BIS-(4,4′-DIMETHYL-2,2′-DIPYRIDYL) CHLORIDES. S. P. Sinha (Cyanamid European Research Inst., Cologny, Switzerland). J. Inorg. Nucl. Chem., 27: 115-18(Jan. 1965).

The reflection spectra of Nd(III)-bis-(2,2′-dipyridyl) and Nd(III)-bis-(4,4′-dimethyl 2,2′-dipyridyl) chlorides were studied. The shift of the line groups towards lower wavenumbers with respect to the aquo-ion indicated direct bonding between neodymium and the nitrogen atoms of the ligands. A quantitative interpretation of the nephelauxetic effect is discussed. (auth)

15499 EUROPIUM DIBENZOYLMETHIDE ADDUCTS. R. G. Charles and R. C. Ohlmann (Westinghouse Electric Corp., Pittsburgh). J. Inorg. Nucl. Chem., 27: 119-27(Jan. 1965).

Europium(III) dibenzoylmethide forms solid adducts with a number of oxygen- and nitrogen-containing Lewis bases. The adducts all show the visible orange-red fluorescence characteristic of trivalent europium. However, the relative fluorescence intensities, as well as the number of resolved fluorescence bands and their wavelength maxima, show significant variation from compound to compound, suggesting that there is direct bonding between the europium ion and the base. The reflection spectra and thermal stabilities of the solid complexes are also discussed. (auth)

15500 NITRATOAQUO COMPLEXES OF NITROSYLRUTHENIUM III. D. Scargill, C. E. Lyon, N. R. Large, and J. M. Fletcher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 161-71(Jan. 1965).

The five complexes with nitrato or aquo groups adjacent to nitrosyl in octahedrally bonded RuNO III were identified by cation exchange, paper chromatography, and extraction using tertiary amines. Assignment of the cis and trans dinitrato complexes was based on the difference on their rates of formation from the mononitrato complex which was governed by a trans nitrato effect. The cis was the more stable form; the ratio [cis]/[trans] at 20°C was about 1:4. It was also the less extractable by organic solvents. In contrast to the behavior shown by other pairs of geometric isomers with hexa coordination, the cis isomer was eluted before the trans isomer from a mixture of the two adsorbed on a cation exchange resin. The mole fractions of the mononuclear complexes at equilibrium in 1 to 12M HNO_3 were measured and the rate constants between them determined. The infrared spectra of the tri- and tetranitrato complexes are given. (auth)

15501 SEPARATION OF BORON ISOTOPES. VII. REACTION OF BORON HALIDES WITH SOME LEWIS BASES CONTAINING OXYGEN, NITROGEN OR SULPHUR. A. A. Palko (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 287-92(Feb. 1965). (ORNL-P-189)

The addition of BCl_3 and BF_3 to tetrahydrofuran (THF), nitrobenzene, NN-dimethyl aniline, N-methyl diphenyl amine, methyl iso-cyanide, thiophenol, and diphenyl sulphide was studied; melting points of the resulting compounds were obtained. The solubility of BF_3 in THF and nitrobenzene was measured for several temperatures at 400 and 760 torr. The change in $^{10}B-^{11}B$ isotopic equilibrium constant with temperature was determined for the nitrobenzene–BF_3 and the THF–BF_3 systems. (auth)

15502 THE PREPARATION OF SAMARIUM BORIDES AND THEIR INTERACTION WITH BORON NITRIDE, MOLYBDENUM AND TUNGSTEN. G. L. Galloway and H. A. Eick (Michigan State Univ., East Lansing). J. Inorg. Nucl. Chem., 27: 293-6(Feb. 1965). (COO-716-9)

It was found that a simple equation does not describe the reaction of samarium sesquioxide and boron, since the products varied with both temperature and length of time at temperature. Metals such as molybdenum and tungsten reacted with samarium boride phases at elevated temperatures forming delta molybdenum boride and tungsten diboride, respectively, and liberated gaseous samarium. It was found that tetraboride specimens of volatile lanthanide elements may be prepared free of the hexaboride by heating the elements in a bomb. (auth)

15503 THE CRYSTAL STRUCTURE OF DISODIUM TETRANITRITONITROSOHYDROXYRUTHENATE(III) 2-HYDRATE BY NEUTRON DIFFRACTION. S. H. Simonsen (Univ. of Texas, Austin) and M. H. Mueller. J. Inorg. Nucl. Chem., 27: 309-20(Feb. 1965).

The crystal structure of $Na_2[Ru(NO_2)_4(NO)(OH)] \cdot 2H_2O$ was determined by neutron diffraction. The unit cell is monoclinic, $a = 12.75$; $b = 14.52$; $c = 7.37$ Å; $\beta = 121.20°$. The space group is C2/m with 4 molecules per unit cell. The ruthenium is octahedrally co-ordinated to four nitrogens of the nitrito groups arranged in a square, the nitrogen of the nitroso, and the oxygen of the hydroxyl group. The ruthenium octahedra are held together by Na–O bridges involving six fold co-ordination about the two crystallographically different sodium atoms. Hydrogen bonding apparently is not important in this crystal. (auth)

15504 TERNARY AND POLYNARY OXIDES OF PROTACTINIUM WITH PEROVSKITE STRUCTURE. C. Keller (Technische Hochschule, Karlsruhe, Ger. and Institut fur Radiochemie, Gesellschaft fur Kernsforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 321-7(Feb. 1965). (In German)

The following ternary or quarternary oxides, containing tetravalent or pentavalent protactinium were obtained by reactions in the solid state: $Ba(Me^{III}_{0.5},Pa^{V}_{0.5})O_3$ (ordered perovskite structure, Me^{III} = rare earths, La, Y, Sc, In, Pu, Am), $Ba_{3-x}Sr_xPaO_{5.50}$ (ordered perovskite-structure; x = 0, 1, 2), $Sr(Lu_{0.5},Pa_{0.5})O_3$, $BaPaO_3$, $SrPaO_3$, $PaO_2 \cdot 2X_2O_5$ (vacancy-type perovskite structure according to $Pa_{0.25}XO_3$, X = Nb, Ta), $NaPaO_3$ ($GdFeO_3$ structure), $KPaO_3$ and $RbPaO_3$. All these compounds possessed perovskite structure or a type of structure deduced from the perovskite lattice. The oxidation of $PaO_2 \cdot 3X_2O_5$ gave $X_2O_5 + Pa_2O_5 \cdot 3X_2O_5$, and the latter had the hexagonal structure of $UO_{2.67} \cdot 1.5Ta_2O_5$. Reaction conditions, lattice constants, and chemical properties of the above mentioned compounds are discussed. (auth)

15505 STUDIES ON PROTACTINIUM(V) IN SULFURIC ACID SOLUTION. I. CENTRIFUGATION STUDY. J. Takagi and H. Shimojima (NAIG Nuclear Research Lab., Suehirocho, Kawasaki, Japan). J. Inorg. Nucl. Chem., 27: 405-9(Feb. 1965).

Centrifugation experiments were carried out to investigate the hydrolytic behavior of protactinium in sulfuric acid solution. While protactinium at a concentration of 10^{-6}M was stable against hydrolysis for at least two weeks in 0.2 to 0.5M sulfuric acid solution; polymeric species, possibly formed by hydrolysis, were observed for tracer concentration (10^{-11}M) protactinium in 0.015 to 0.5M sulfuric acid. For protactinium at tracer concentration the results suggested that polymeric species with an approximate radius of 10 to 15 Å are in equilibrium with ionic or molecular species. (auth)

15506 MATRIX ELEMENTS OF A RHOMBIC POTENTIAL FOR F^n SYSTEMS (n ODD). R. Pappalardo (Cyanamid European Research Inst., Cologny, Switzerland). J. Mol. Spectry., 15: 105-11(Feb. 1965).

A tabulation is given of matrix elements of rhombic potentials up to the sixth degree, connecting states characterized by given J and M_J values. The values of J are the half-integers up to $15/2$, commonly required in the fine structure analysis of the spectra of rare earth ions. (auth)

15507 ELECTROLYTIC URANIUM DIOXIDE FROM URANYL HALIDES. Naohiko Hamabe and Chuko Ito

(Mitsubishi Metal Mining Co., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 2: 7-12(Jan. 1965).

Fused-salt-electrolysis preparation of uranium dioxide was demonstrated to be applicable to uranyl fluoride resulting from the hydrolysis of uranium hexafluoride. The potential pO^{2-} (negative logarithm of the activity of O^{2-} ion) diagram was used for guidance in electrowinning of UO_2 from fused halides. Acceptors of O^{2-} ion were found to produce good melts with sufficient dryness for obtaining sound UO_2. Polarograms of uranyl reduction showed that uranium oxide would exist in the form of UO_2(V) as an intermediate species at low concentrations of UO_3(VI). Carbon anodes in molten solution containing UO_3(VI) acted as UO_2 electrodes prior to the electrolysis, so that low cell voltages such as 0.05 V were sufficient at low current densities. Crystalline UO_2 particles produced in an electrolytic pilot unit with a capacity of 1 kg oxide had a density of up to 10.75 g/cm³ and total impurities were less than 0.1%. (auth)

15508 IDENTIFICATION OF THE ACTIVE SITE IN ZIEGLER TYPE CATALYSTS BY TRANSFER AND EXCHANGE REACTION STUDIES WITH DEUTERIUM. A. Schindler (Research Triangle Inst., Durham, N. C.). J. Polymer Sci. Pt. B, 3: 147-9(Feb. 1965).

Infrared analysis of polyethylene prepared in the presence of deuterium revealed the formation of two characteristic groups corresponding to the two possibilities of the adsorbed deuterium molecule to react with the growing chain, which proceeds from the transition metal center in Ziegler type catalyst. The catalysts used were $TiCl_4$ and $VOCl_3$ in combination with either Et_2AlCl or $ZnEt_2$. (M.C.G.)

15509 OCTAFLUOROPROTACTINATES (V). D. Brown and J. E. Easey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 205: 589(Feb. 6, 1965).

In an investigation on the preparation and properties of the fluoro-complexes of quinquevalent protactinium, using bromine trifluoride and aqueous hydrofluoric acid as solvents, lithium and sodium octafluoro-protactinates (V), Li_3PaF_8 and Na_3PaF_8, respectively, were isolated from reactions in the latter solvent. The octafluoroprotactinates (V) are white, nonhygroscopic solids, which are soluble in dilute hydrofluoric acid, water, and dilute nitric acid. No signs of hydrolysis were observed. The sodium salt is isostructural with sodium octafluorouranate (V), possessing tetragonal symmetry. The lithium complex, for which there appears to be no quinquevalent Nb, Ta, and U analog, is also tetragonal. (P.C.H.)

15510 ON THE DISSOLUTION OF OXYGEN IN ZIRCONIUM. Gunji Shinoda (Osaka Univ.) and Yoshitsugu Amano. Nippon Kinzoku Gakkaishi, 28: 639-44(1964). (In Japanese)

The nature of dissolution of oxygen in zirconium heated in air or under a low pressure was studied by metallographic and x-ray methods. Dissolution of oxygen in zirconium was found to change from the grain boundary diffusion type to the bulk diffusion type with increasing temperature. The lattice constant of zirconium increased with the degree of dissolution of oxygen at first, reached a maximum at about 18 at. % O, and then decreased. The degree of x-ray transmission in both of the welded zone and the heat-affected zone was larger than that of the non-welded zone. The rate of oxidation was larger in the welded zone than that in the non-welded zone. The rate of recrystallization was accelerated by oxygen atoms dissolved in zirconium during recrystallization. (auth)

15511 ON THE THERMAL RELAXATION TIMES OF SPECIAL LIQUIDS IN NUCLEAR MAGNETIC RESONANCE. A. Carrelli and E. Ragozzino (Universita, Naples). Nuovo Cimento (10), 35: 731-4(Feb. 1, 1965).

The values of the thermal relaxation time T_1, in proton resonance, were determined for some solutions of macromolecular substances (tylose in water, gelatine in water, masticated rubber in benzene) with low concentration, but with viscosity varying in a wide range. These values are not practically affected by the viscosity change. From these results it is determined that in the solutions tested the water and benzene molecules have almost the same mobility that they have in pure solvent. (auth)

15512 CALCULATION OF THE PROBABILITIES OF RADIATIONLESS TRANSITIONS FOR THE Tb^{3+} ION IN AQUEOUS SOLUTIONS. D. N. Terpilovskii. Opt. Spectry. (USSR) (English Transl.), 17: 384-6(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 712-17(Nov. 1964).

Stark splitting of energy levels and locations of the fine structure lines of ion fluorescence bands were calculated on the basis of the Tb^{3+} being in aqueous solution surrounded by six molecules of water. Nonradiative transitions, caused by a modulation by Brownian movement of vibrations of the solvate envelope, were considered. The probabilities of such transitions from lower levels of radiative transitions were calculated. The broadening of energy levels was compared to the width of fluorescence lines; a satisfactory agreement with experiment was obtained. (auth)

15513 LUMINESCENCE OF NEODYMIUM IN SINGLE CRYSTALS OF LEAD MOLYBDATE. Ya. E. Kariss and P. P. Feofilov. Opt. Spectry. (USSR) (English Transl.), 17: 387-9(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 718-23(Nov. 1964).

The absorption and luminescence spectra of monocrystalline $PbMoO_4$, activated with Nd^{3+}, was investigated in the near-infrared region at 300, 77, and 4.2°K. An empirical scheme was developed for crystalline splitting of the $^4I_{9/2-11/2}$ and $^4F_{3/2}$ terms. (auth)

15514 ELECTRO-X-RAY LUMINESCENCE OF ALKALI-HALIDE COMPOUNDS. A. S. Andrianov, M. L. Kats, L. A. Kirillov, and V. V. Fomichev. Opt. Spectry. (USSR) (English Transl.), 17: 398-401(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 739-44(Nov. 1964).

Results of an investigation on the effect of an electric field on x-ray luminescence, thermoluminescence, and the quenching of the luminescence of alkali-halide compounds are presented. (auth)

15515 FLUORESCENT PROPERTIES OF TERBIUM-ACTIVATED ALKALINE-EARTH BORATES. W. L. Wanmaker and A. Bril. Philips Res. Rept., 19: 479-97(Oct. 1964).

Terbium-activated alkaline earth borates, excited with short-wavelength ultraviolet radiation, showed luminescence with an emission spectrum characteristic of terbium. Quantum efficiencies of more than 40% were obtained with excitation in the 250 to 270 mm region. The excitation spectra of the terbium emission, the total light output of the terbium fluorescence as a function of the exciting wavelength, showed a broad excitation band with a peak at about 240 nm. Phosphors activated with terbium and gadolinium had excitation spectra with sharp Tb-emission peaks at exciting wavelengths that coincided with absorption lines due to Gd ions. This was explained as a transfer of energy absorbed by the Gd ions to the Tb activator ions. The decay times of the phosphors were found to lie between 1.9 and 2.6 msec. Hitherto unpublished x-ray-diffraction patterns of the compounds $3SrO \cdot B_2O_3$, $2SrO \cdot B_2O_3$, and $SrO \cdot 2B_2O_3$ are given. (auth)

15516 SPIN-LATTICE RELAXATION OF TETRAVALENT Pa^{231} IN Cs_2ZrCl_6. L. J. Raubenheimer, E. Boesman, and H. J. Stapleton (Univ. of Illinois, Urbana). Phys. Rev., 137: A1449-54(Mar. 1, 1965). (COO-1198-207)

The paramagnetic relaxation time was measured for Pa^{4+} in the cubic matrix Cs_2(99% Zr, 1% Pa)Cl_6 between 1.4 and 4.2°K, using pulse-saturation techniques. This complex, with its known and comparable spin-orbit and crystal field interactions, was chosen to determine whether the approximations for the orbit-lattice interaction, which are apparently valid for rare-earth ions, would remain so for ions of the 5f transition group. The data fit $T_1^{-1} = A'T + C'T^9$, where $A' = 3.46 \pm 0.34$ sec^{-1} deg^{-1} and $C' = 5.1 \times 10^{-6} \pm 1.5 \times 10^{-6}$ sec^{-1} deg^{-9}. The static crystal field parameters $A_4^0\langle r^4\rangle = 888$ cm^{-1} and $A_6^0\langle r^6\rangle = 41.9$ cm^{-1} are used to estimate the coupling parameters $|a_4^m\langle r^4\rangle|$ and

$|a_4^m\langle r^6\rangle|$ to the fourth- and sixth-degree spherical harmonics in the orbit-lattice interaction. The coupling to the second-degree spherical harmonics is treated in terms of a single parameter $|a_2^0\langle r^2\rangle|$. The speed of longitudinal sound waves in a polycrystalline sample of pure Cs_2ZrCl_6 was measured and found to be 4.5×10^5 cm/sec. Using this value for the effective phonon velocity, the theoretical relaxation rate is computed in terms of the single parameter $|a_2^0\langle r^2\rangle|$. A comparison with the experimental direct-process coefficient A′ indicates $|a_2^0\langle r^2\rangle| \approx 17{,}000\ cm^{-1}$, while comparison with the Raman coefficient C′ yields $|a_2^0\langle r^2\rangle| \approx 30{,}000\ cm^{-1}$. A dynamic point-charge model, based upon a phonon-induced distortion of the octahedron of Cl^- ions surrounding the Pa^{4+} site, shows that $|a_2^0\langle r^2\rangle|$ should be approximately $23{,}000\ cm^{-1}$ if it is to be consistent with the values of $|a_4^m\langle r^4\rangle|$ and $|a_6^m\langle r^6\rangle|$ obtained from the static crystal field parameters. This reasonable agreement supports the contention that estimating correct order-of-magnitude spin-lattice relaxation rates by Orbach's simple phenomenological approach is not restricted to the rare-earth series. (auth)

15517 TWO-QUANTUM ABSORPTION SPECTRUM OF KI AND CsI. J. J. Hopfield and J. M. Worlock (Univ. of California, Berkeley). Phys. Rev., 137: A1455-64(Mar. 1, 1965).

The measurement of the two-quantum fundamental absorption edge in KI and CsI at 300, 77, and 4°K is described. Selection rules, exciton models, phonon coupling, and the theory of two-quantum absorption are briefly discussed. Comparison of the present results with theory and the one-quantum absorption leads to the quantitative understanding of the shape and magnitude of the two-quantum spectrum. It is shown that one-electron band structure and Wannier excitons, rather than excitation models, provide the best understanding of the low-energy part of the fundamental absorption edges in the materials studied. (auth)

15518 NEW DATA ON THE RELAXED EXCITED STATE OF THE F CENTER. Giorgio Spinolo (Univ. of Illinois, Urbana). Phys. Rev., 137: A1495-6(Mar. 1, 1965).

Ionization energies ΔE and lifetimes τ_R of the excited state of the F center were measured in various alkali halides. The experimental values of ΔE were plotted versus $(m^*/m)\ (1/\epsilon S^2)$, following Fowler's idea that in emission the excited-state wave function is very broad. The hydrogenic model seems to fit the data very well, and Fowler's theory finds strong experimental support. (auth)

15519 ENERGY LEVELS OF Dy^{2+} IN THE CUBIC HOSTS OF CaF_2, SrF_2, AND BaF_2. Zoltan J. Kiss (RCA Labs., Princeton, N. J.). Phys. Rev., 137: A1749-60 (Mar. 15, 1965).

The absorption and fluorescence spectrum of Dy^{2+} in the cubic hosts of CaF_2, SrF_2, and BaF_2 was investigated. The crystal-field components of the $^5I_7$ and $^5I_8$ states were established and the cubic field parameters for the three hosts were deduced. The laser transition in the $CaF_2:Dy^{2+}$ system was identified and some of the laser characteristics were delineated. The 4f-4f transitions of Dy^{2+} were found to be of magnetic dipole origin. The nonradiative processes in the above systems are discussed. (auth)

15520 ZEEMAN EFFECT STUDIES OF THE $^5I_7$–$^5I_8$ TRANSITION IN $CaF_2:Dy^{2+}$. Z. J. Kiss, C. H. Anderson, and R. Orbach (RCA Labs., Princeton, N. J.). Phys. Rev., 137: A1761-6(Mar. 15, 1965).

Zeeman effect studies of $^5I_7$–$^5I_8$ fluorescent transitions of the $CaF_2:Dy^{2+}$ system were carried out. The symmetries and the spectroscopic splitting factors of a number of crystal field components were determined, and the transitions were found to be of magnetic dipole origin. Effects due to magnetic interactions among the lowest three crystal field components of the ground state were observed. The orientation dependence of the Zeeman pattern of the $|7T_1^{(2)}\rangle \rightarrow |8T_1^{(2)}\rangle$ laser transition is treated. (auth)

15521 ZEEMAN EFFECT IN THE 4f → 5d SPECTRUM OF Ce^{3+} IN CaF_2. M. H. Crozier (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 137: A1781-3(Mar. 15, 1965).

The Zeeman effect of the Ce^{3+} ion with tetragonal charge compensation in CaF_2 was studied at 4.2°K. An absorption line at 3131.6 Å was split with fields of 60 kg, and although all the components cannot be resolved, there is good agreement with EPR results for the ground state. Axial stress results identify the upper state as having crystal quantum number $\mu = \pm\frac{1}{2}$. The occurrence of $4f^n \rightarrow 4f^{n-1}5d$ spectra in the trivalent rare earths is discussed. A result is established concerning the use of the Zeeman effect to identify the $\mu = \pm\frac{1}{2}$ and $\mu = \pm\frac{3}{2}$ components of a cubic Γ_8 level split by a tetragonal distortion. (auth)

15522 LOW-TEMPERATURE MAGNETIC TRANSITIONS IN SOME RARE-EARTH TRICHLORIDES. J. C. Eisenstein, R. P. Hudson, and B. W. Mangum (National Bureau of Standards, Washington, D. C.). Phys. Rev., 137: A1886-95(Mar. 15, 1965).

The magnetic susceptibilities of $CeCl_3$, $PrCl_3$, and $NdCl_3$ single crystals and of polycrystalline $SmCl_3$ were measured in the temperature region between 0.2 and 4.2°K. Each of these compounds exhibits anomalous behavior. $NdCl_3$ has two extremely sharp spikes in its susceptibility-versus-T curve at 1.035 and 1.745°K. These spikes are strongly affected by a weak external field and also depend on the amplitude and frequency of the a-c measuring field. $CeCl_3$ has a single sharp spike in its susceptibility at 0.345°K. $PrCl_3$ and $SmCl_3$ have rather broad maxima in their susceptibilities at about 0.7 and 0.4°K, respectively. It is shown, on the basis of a simple molecular field model, that the superexchange coupling between nearest neighbors is ferromagnetic, while that between next-nearest neighbors is antiferromagnetic. The two spikes in the $NdCl_3$ susceptibility curve are ascribed to two successive cooperative magnetic transitions. An attempt is made to correlate in a quantitative way the temperatures of the transitions in $CeCl_3$ and $NdCl_3$, and to explain why no similar transitions were observed in $PrCl_3$. (auth)

15523 MAGNETIC STRUCTURE OF $CuSO_4$. I. Almodovar (Puerto Rico Nuclear Center, Mayaguez), B. C. Frazer, J. J. Hurst, D. E. Cox, and P. J. Brown. Phys. Rev., 138: A153-5(Apr. 5, 1965). (BNL-8557)

The antiferromagnetic structure of anhydrous cupric sulfate, $CuSO_4$, was determined from neutron-diffraction powder data and by use of the single-crystal susceptibility results of Kreines. A least-squares refinement of the crystal structure was also carried out in order to obtain a good absolute scale factor for the neutron analysis. The original x-ray data of Kokkoros and Rentzeperis were used in these calculations. The magnetic structure is collinear, with +−+− ordering on the 000, $00\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}0$, and $\frac{1}{2}\frac{1}{2}\frac{1}{2}$ sites in the Pbnm orthorhombic cell. The Cu^{2+} moment was found to be 0.83 ± 0.10 Bohr magnetons with the spin-axis orientation parallel to the a axis of the unit cell. (auth)

15524 ANTIFERROMAGNETIC STRUCTURE OF DYSPROSIUM ALUMINUM GARNET. J. M. Hastings (Brookhaven National Lab., Upton, N. Y.), L. M. Corliss, and C. G. Windsor. Phys. Rev., 138: A176-7(Apr. 5, 1965). (BNL-8601)

The low-temperature antiferromagnetic structure of $Dy_3Al_5O_{12}$(DAG) was established by means of neutron diffraction. The spin arrangement consists of six interpenetrating substructures directed along ±X, ±Y, ±Z, as predicted by Wolf and co-workers. The observed value of the Dy^{+3} moment is 9.0 ± 0.5 μ_B, in agreement with the g value obtained from esr measurements. (auth)

15525 R CENTER IN KCl; STRESS EFFECTS IN OPTICAL ABSORPTION. R. H. Silsbee (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 138: A180-97(Apr. 5, 1965). (NYO-2150-2)

The R_2 optical absorption band in KCl shows a prominent zero-phonon line at liquid-helium temperature. This line may be split by application of uniaxial stress to the crystal, and the qualitative dependence of this splitting upon the direction of the stress and the polarization of the measuring light implies that the absorption is to be associated with a

defect with a [111] axis of symmetry. The dependence of the intensities of the split components upon stress implies that the ground state is degenerate. The ground and low-lying excited states of van Doorn's F_3 model are discussed in terms of a continuum model for this center, as well as the implications of the Jahn-Teller effect which results from the coupling of these electronic states to the lattice vibrations. These considerations, in addition to being consistent with the results on the zero-phonon line, predict a stress-induced dichroism in all of those broad-band absorptions of the center which have transition moments in the plane of the triangle of F centers. An experimental study of the stress-induced dichroism has allowed the identification of six distinct transitions of the R center: a transition in the region of the N bands, one near the M band, the familiar R_1 and R_2 bands, a broad transition underlying the R_1 and F bands, and a narrow band on the violet side of the F band. The symmetry of the corresponding excited states is also obtained from the nature of the stress-induced dichroism. These experimental results are consistent with the qualitative predictions of the continuum F_3 model. These conclusions, supplemented by results on the spin quartet states of the R center and by polarized bleaching experiments, give the relative locations of ten distinct states of the R center. (auth)

15526 INFLUENCE OF PARAMAGNETIC IMPURITIES ON THE TEMPERATURE DEPENDENCE OF NUCLEAR MAGNETIC RESONANCE LINES. T. G. Stoebe, T. O. Ogurtani, and R. A. Huggins (Stanford Univ., Calif.). Phys. Rev., 138: A239-40(Apr. 5, 1965).

The theory of paramagnetic impurity broadening of nuclear magnetic lines in diamagnetic crystals is considered. The concept of a critical radius around each paramagnetic ion, inside which nuclei do not contribute to the observed resonance line, is discussed. It is shown that the inclusion of the temperature dependence of this critical radius gives rise to a T^{-1} dependence for the contribution to the second moment due to such paramagnetic dipoles. This temperature dependence qualitatively explains experimental low-temperature ^{7}Li linewidth variations in Mn-doped LiF. (auth)

15527 NUCLEAR RESONANCE IN EuS FROM 4.2°K TO THE CRITICAL TEMPERATURE REGION. P. Heller and G. Benedek (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 14: 71-4(Jan. 18, 1965).

The temperature dependence of the zero-field nuclear resonance frequencies of ^{151}Eu and ^{153}Eu in EuS powder was measured from 4.2 to 16.33°K, using a frequency-modulated spectrometer operating up to 210 Mc/sec. The critical temperature was determined, together with the extent of the pulling of the NMR frequency due to perturbation of the electronic magnetization by the precession of the nuclear polarization. (D.C.W.)

15528 ISOTOPIC DISPLACEMENT, THEORETICAL CALCULATION, AND STRUCTURE OF TERMS IN THE ARC SPECTRUM OF OSMIUM. G. G. Gluck, Y. Bordarier, J. Bauche, and Th. A. M. Van Kleef (Centre National de la Recherche Scientifique, Bellevue, France). Physica, 30: 2068-2104(Nov. 1964). (In French)

Because of the measurement of isotopic displacements in the spectrum of Os I, the preponderant configurations of 18 low even levels, 4 high even levels, and 43 odd levels were determined. The experimental isotopic displacement constant was recalculated (114 ± 14 mK). The 49 low even levels (of which 3 are new) were confirmed by theoretical study of the three configurations $5d^66s^2$, $5d^76s$, and $5d^8$. The position of the $5d^8$ was determined. Thirty-two new odd levels and one high even level were found. A total of 505 new lines were classified, which carries to 3473 the total number of lines classified, corresponding to 3872 transitions. The reinterpretations of some low even levels and many odd levels are given. (tr-auth)

15529 ISOTOPE EFFECT AND TEMPERATURE DEPENDENCE OF ULTRAVIOLET OH AND OD BANDS IN KCl. F. Fischer (Inst. of Physics, Gottingen, Ger.). Solid State Commun., 2: 51-3(Feb. 1964). (In German)

An isotope effect was observed in an electron band in alkali halides. At 20°K the OD-band (OH-band) was found at 6.10 ev (6.05 ev) with a half width of 0.55 ev (0.64 ev). Both differences could be interpreted by the Franck-Condon principle. The temperature shift of the band maxima was abnormal below 100°K. (auth)

15530 THE CONTROLLED OXIDATION OF SINGLE CRYSTALS OF UO_2 TO U_4O_9. W. Van Lierde and L. De Jonghe (SCK-CEN, Mol, Belg.). Solid State Commun., 2: 129-31(May 1964).

A simple and reliable method is presented for the controlled oxidation of UO_2, which allows the preparation of single crystals with a composition between UO_2 and U_4O_9 starting from a stoichiometric crystal. The principle of the method is the equilibration of the oxygen dissociation pressures of UO_2 and U_3O_8 heated together in vacuum. The practical applications are shown. (auth)

15531 IONIC CHARACTERS FROM MÖSSBAUER ISOMER SHIFTS. V. G. Bhide, G. K. Shenoy, and M. S. Multani (Inst. of Science, Bombay). Solid State Commun., 2: 221-3(Aug. 1964).

The isomeric shift, δ, in the Mössbauer resonance curve when referred to a standard source is shown to be linearly dependent on the ionic character of the absorber in simple cases such as the aurous halides. In ferrous and ferric salts, where complications occur due to d-s and s-p overlap, the linear relation no longer holds. The plot between δ and the ionic character of the absorber salt as determined from Pauling's formulation was used to determine the degree of covalency in iron-doped $BaTiO_3$. The value thus determined agreed well with that inferred theoretically. (auth)

15532 THE TRIPLET STATES OF THE M CENTER. R. F. Wood and Axel Meyer (Oak Ridge National Lab., Tenn.). Solid State Commun., 2: 225-8(Aug. 1964).

Results of calculations of the electronic structure of the triplet states of the M center in LiF and LiCl are given. The results indicated that the triplet and singlet ground states lie close together. Decay modes of the triplet state are discussed. (auth)

15533 INFRARED DISPERSION FREQUENCIES FOR ALKALI HALIDES. C. M. Randall, R. M. Fuller, and D. J. Montgomery (Michigan State Univ., East Lansing). Solid State Commun., 2: 273-5(Sept. 1964). (TID-20865)

Infrared absorption spectra of evaporated thin films of LiI were obtained to complete the list of infrared dispersion frequencies for all the alkali halides. (auth)

15534 INVESTIGATION OF THE DIELECTRIC CONSTANT AND LOSS IN CERTAIN SOLID SOLUTIONS BASED ON CERIUM ALUMINATE. V. A. Ioffe, A. I. Leonov, and M. V. Razumeenko (Grebenshchikov Inst. of Silicate Chemistry, Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1833-38(Feb. 1965). Translated from Fiz. Tverd. Tela, 6: 2314-21(Aug. 1964).

The complex dielectric constant of aluminates of rare earth elements having a perovskite-type structure and certain solid solutions based on cerium aluminate was investigated. An anomalous shift of the maximum value of ε'' with temperature was observed in some specimens. It was established that small additions (about 0.1%) of aluminates of samarium or europium lower the dielectric constant of $CeAlO_3$ to the normal value. (auth)

15535 NONLINEAR PROPERTIES OF CERIUM ALUMINATE. V. A. Ioffe, A. I. Leonov, and M. V. Razumenko (Inst. of Silicate Chemistry, Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1908-12(Feb. 1965). Translated from Fiz. Tverd. Tela, 6: 2405-10(Aug. 1964).

The dielectric hysteresis loop, dependence of the reversible dielectric constant on the bias field, and the electrical conductivity of $CeAlO_3$ and some of its solid solutions were investigated. Dielectric hysteresis loops are disclosed for samples with anomalous dielectric properties. The conductivity of these samples depended exponentially on the field strength. The reversible dielectric constant did not depend on the bias field strength. The

dielectric hysteresis loops were caused by the fact that the conductivity depended nonlinearly on the field strength and not by the ferroelectric properties of $CeAlO_3$. (auth)

15536 DISLOCATION ROSETTES IN CsI. A. A. Urusovskaya and R. Tyagaradzhan (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 9: 440-4(Jan.-Feb. 1965). Translated from Kristallografiya, 9: 531-6(July-Aug. 1964).

The distribution of dislocations in CsI in the range of action of a concentrated load was studied by the selective etch method. On the indented (001) surface, the dislocations formed a rosette having four arms, directed along the cube edge. The form of the dislocation loops in the arms of the rosette and below the indented surface in the body of the crystal was studied. A large number of prismatic loops was found. The processes of interaction of dislocations in crystals having a cesium chloride lattice were examined. (auth)

15537 Li^6-Li^7 ISOTOPE EFFECT IN THE INFRARED SPECTRA OF INORGANIC COMPOUNDS OF LITHIUM. I. CARBONATE, CHROMOFERRITE, TUNGSTATE, MOLYBDENATE AND NITRATE OF LITHIUM. P. Tarte (Universite, Liege). Spectrochim. Acta, 21: 313-19(Feb. 1965). (In French)

The infrared spectra of crystalline Li_2CO_3, $LiFeCr_4O_8$, Li_2WO_4, Li_2MoO_4, and $LiNO_3$, and the isotopic species with ^6Li were studied in the 1600 to 290 cm^{-1} region. In the first four compounds, bands related to the stretching frequency of LiO_4 tetrahedra were easily identified by a $^6Li-^7Li$ isotopic shift of 20 to 30 cm^{-1}, an amount in agreement with a theoretical estimation. Despite the diversity in chemical composition and crystal structure of the compounds studied, these LiO_4 bands were observed in a fairly well defined region, 500 to 400 cm^{-1}. No Li–O bands, however, were found in the spectrum of $LiNO_3$, the structure of which contains LiO_6 octahedra (and no LiO_4 tetrahedra), and it was inferred that the stretching frequencies of LiO_6 octahedra should be located below 300 cm^{-1}. This difference in the spectroscopic behavior of LiO_4 tetrahedra and LiO_6 octahedra may be used for determining the coordination number of lithium in compounds of unknown structure. (auth)

15538 CONTROLLED ADDITION OF SMALL AMOUNTS OF OXYGEN TO NIOBIUM (COLUMBIUM). C. S. Tedmon, Jr., R. M. Rose, and J. Wulff. Trans. AIME, 230: 1732-4 (Dec. 1964).

A technique was developed for the controlled addition of oxygen to niobium at very dilute concentrations with an estimated accuracy of the order of ±2 ppm by weight. The oxygen is deposited in an anodized layer and diffuses into the interior of the sample. An example of use of the technique is described. (M.C.G.)

15539 SYSTEM $UO_3 + U_3O_8$: DISSOCIATION PRESSURE OF γ-UO_3. E. H. P. Cordfunke and P. Aling (Reactor Centrum Nederland, Petten, Netherlands). Trans. Faraday Soc., 61: 50-3(Jan. 1965).

The oxygen pressure of the system γ-$UO_3 + U_3O_8$ was measured as a function of temperature. The results can be expressed as $\log p_{O_2}(mm) = (-12338/T) + 16.192$. The heat of formation of γ-UO_3 derived from the measurements, is $\Delta H_{298°K} = -293.5$ kcal/mole. A tentative phase diagram for the system $UO_3 + U_3O_8$ is suggested. (auth)

15540 CALCIOTHERMIC REDUCTION OF NIOBIUM (COLUMBIUM) PENTOXIDE. C. K. Gupta and P. K. Jena (Atomic Energy Establishment, Trombay, India). Trans. Met. Soc. AIME, 230: 1433-8(Oct. 1964).

Niobium metal in the form of a button was produced by calciothermic reduction of niobium pentoxide using sulfur as the heat booster. In these experiments with 50 g of niobium pentoxide per batch, the influence of percentage of calcium in excess of the stoichiometric, the percentage of sulfur by weight of the niobium oxide, and the outer-wall temperature of the bomb on the quality and yield of the metal was studied. The maximum yield on this metal was studied. The maximum yield on this scale was 78% using 50% excess Ca and 20% S and at a bomb wall temperature of 600°C. In experiments conducted on 500 g of niobium pentoxide, reduction with 40% excess Ca and 20% S, and at a bomb wall temperature of 500°C, the yield of the metal improved to 82 to 84%. Some of the reduced metal samples were electron-beam melted and the button melts thus obtained were observed to be extremely ductile and capable of cold reduction to 98% without intermediate annealing. (auth)

15541 ON THE PREPARATION OF METAL NITRIDES FROM AMMONIUM FLUOROMETALLATES AND AMMONIA. H. Funk and H. Boehland (Martin Luther-Universitat, Halle, Ger.). Z. Anorg. Allgem. Chem., 334: 155-62(Dec. 1964). (In German)

The thermolytic decomposition of various ammonium fluorometallates in an atmosphere of gaseous ammonia was investigated at various temperatures and conditions. This method was found to be favorable for preparing the following nitrides AlN, VN, NbN, Ta_3N_5, CrN, U_3N_4 (from UF_4), and Fe_2N. (auth)

15542 ON COMPOUNDS OF THE TYPE $Me^{II}_{0.5}Me^{IV}_{0.5}X^VO_4$ WITH HUTTONITE OR ZIRCON STRUCTURE. II. VANADATE. (Me^{II} = Cd, Ca, Sr, Pb, Ba; Me^{IV} = Th; X^V = V). H. Schwarz (Technische Hochschule, Karlsruhe, Ger.). Z. Anorg. Allgem. Chem., 334: 261-71(Jan. 1965). (In German)

The lattice dimensions of the vanadates $Me^{II}_{0.5}Th_{0.5}VO_4$, where Me^{II} = Cd, Ca, and Sr, crystallizing with zircon ($ZrSiO_4$) structure, are presented. $Ba_{0.5}Th_{0.5}VO_4$ has the structure of huttonite ($ThSiO_4$). In the case of $Pb_{0.5}Th_{0.5}VO_4$, in addition to the low-temperature (scheelite type) and the high-temperature (huttonite type) structure, at moderate temperatures a third modification having the structure of zircon occurred. (auth)

15543 REACTION CONDITIONS AND REACTION ZONE MOVEMENT FOR THE CATALYTIC OXYHYDROGEN GAS REACTION IN AN APPARATUS SIMULATING THE BER REACTOR. C. O. Fischer and K. Wasserroth (Hahn-Meitner-Institut fur Kernforschung, Berlin). Z. Naturforsch., 19a: 1404-8(Dec. 1964). (In German)

Investigation of the oxyhydrogen gas reaction resulted in conclusions on the ignition of the reaction, the reaction-determining step of the conversion, and the poisoning of the catalyst by water vapor. The experimental results made it possible to estimate the stationary reaction condition. In the conditions of interest, only "stable reaction conditions" occurred in the sense of the theory of Wagner and Wicke; an ignition zone movement was therefore not possible. A reaction zone movement, connected with the deactivating effect of water vapor, was realized in the discharge. The velocity of the moving reaction zone was measured, and its dependence on the current velocity and hydrogen concentration determined. (tr-auth)

15544 NUCLEAR QUADRUPOLE RESONANCE IN MOLECULAR COMPOUNDS. D. Biedenkapp and Alarich Weiss (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 19a: 1518-21(Dec. 15, 1964). (In German)

In the molecular compounds $SnCl_4 \cdot 2\,X$ [X = $POCl_3$, $(C_2H_5)_2O$]; $2\,SbCl_3 \cdot X$ (X = Benzene, Naphthalene, Biphenyl, p-Xylene); $HgCl_2 \cdot$ Dioxane; and $POCl_3 \cdot AsCl_3$, the NQR-frequencies of ^{35}Cl, ^{121}Sb, and ^{123}Sb were investigated at liquid nitrogen temperature. The shifts of the NQR-frequencies in these compounds, compared with the pure components, are discussed qualitatively. (auth)

15545 THEORETICAL INVESTIGATIONS INTO THE ORIGIN OF THE CRYSTALLINE ELECTRIC FIELD FOR RARE EARTH IONS IN CRYSTALS. D. K. Ray (Saha Inst. of Nuclear Physics, Calcutta). p.321-34 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A review is given of theoretical investigations on the origin of crystalline electric fields as experienced by rare earth ions when present in crystals. The crystalline electric field parameters for rare earth ions were calculated by the ionic model. The induced moment effect and the shielding effect on the crystal potential were discussed. (C.E.S.)

15546 GENERALIZED SPIN HAMILTONIAN AND NUCLEAR QUADRUPOLE INTERACTION FOR RARE EARTH TRICHLORIDES. M. N. Ghatikar, Tuhina Ray, and D. K. Ray (Saha Inst. of Nuclear Physics, Calcutta). p.336-48 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The form of the spin hamiltonian for the rare earth trichlorides was evaluated, using a method for a generalized spin hamiltonian for paramagnetic ions in crystals of any symmetry. Nuclear quadrupole splitting of the ground and some excited levels are determined specifically for $PrCl_3$. The thermal average of the splittings is plotted as a function of temperature. The nuclear quadrupole antishielding factor evaluated previously for Pr^{3+} is used to estimate the ionic contribution to the field gradient. (M.J.T.)

15547 MAGNETIC RESONANCE IN SOME DEUTERATED COMPOUNDS. S. S. Dharmatti, V. Saraswati, and R. Vijayaraghavan (Tata Inst. of Fundamental Research, Bombay). p.396-401 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A study was made of NMR in deuterated borax, its lower hydrates, oxalic acid dihydrate, glycine, biphenyl, formaldehyde, and boric acid. Results of coupling constants are given, and the first order line shapes for D^2 in a polycrystalline sample for different values of the asymmetry parameter are interpreted in terms of previous values of Chiba. (M.J.T.)

15548 FLUORESCENCE SPECTRA OF CERTAIN RARE EARTH CHLORIDES CONTAINING URANYL ION. R. M. Dixit (Atomic Energy Establishment, Trombay, India). p.462-4 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Many inorganic compounds of rare earths show fluorescence due to trivalent rare earth ions. The uranyl compounds also show fluorescence due to UO_2^{2+}. A study was made of the mutual effect of these ions as revealed by their fluorescence spectra in crystals containing both ions. Oxides of La, Sm, Eu, Tb, Y, and Dy were converted to chlorides to which 10% UO_2Cl_2 by weight was added. The mixture was dissolved in distilled water, and crystals were grown. Fluorescence spectra of these crystals were discussed. (C.E.S.)

15549 POSITRONIUM CHEMISTRY. James Green and John Lee. New York, Academic Press, 1964. 114p. $5.50.

The quantum electrodynamics of positron interactions is discussed. Experimental data and methods for obtaining it are described. Positrons in gases or solids, the theoretical chemistry of positronium, positronium chemistry in gases, and positronium chemistry in the condensed state are discussed. Applications to physical and biological sciences are suggested. (M.C.G.)

15550 X-RAY DIFFRACTION STUDIES ON MODIFIED α-TUNGSTEN CARBIDE. Ilona Waldhauser (Industrial Research Inst. for Telecommunication Technique, Budapest). p.251-6 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963.

The orientated hexagonal L'_3 structure (close-packed hexagonal with carbon atoms in octahedral interstices) of α-W_2C wire is changed significantly by the modification process. This structural change is accompanied by increased emission values. X-ray powder patterns of the modified carbide show the body-centered cubic structure of randomly oriented W crystals and some faint diffraction rings. Their interpretation was attempted by assuming that the modification process produces an unstable high-temperature face-centered cubic W_2C or W allotropic modification in which the C atoms occupy octahedral interstices. The carbon is then precipitated in the form of a complex η_2 carbide ($E9_3$ structure) inside the crystal grains and so the tungsten, depleted of its carbon content, is able to return to its preferred body-centered cubic structure, but loses its initial orientation in this process. (auth)

15551 PART I. STUDIES OF ALKALOIDS. PART II. DEUTERIUM ISOTOPE EFFECT STUDIES ON THE PYROLYSIS OF CARBALKOXYPHOSPHONIUM SALTS. Dorit Low Noether. Thesis, New Brunswick, N. J., Rutgers Univ., 1964. 65p.

Part I: From two Kg of bark of Tabermontaemontana accedens, 150 mg of an alkaloid, montaccedine (m.p. 207-211°), was isolated. The elemental analysis indicated the presence of one oxygen and two nitrogen atoms per molecule. The infrared spectrum indicated the absence of a carbonyl group and primary or secondary amino groups, and the presence of a primary hydroxyl group and a quinuclidine structure for one of the nitrogens. An indole nucleus was eliminated on the basis of the NMR spectrum. Attempts were made to synthesize the nonaromatic portion of ibogamine by reduction of 3-carboxy-1-alkyl-pyridinium salts followed by a Diels-Alder condensation with ethyl acrylate. No characteristic products were obtained. Part II: The hypothesis that the pyrolysis of carbalkoxymethylphosphonium salts occurs with increasing carbonium ion contribution as one proceeds from primary to tertiary alkyl salts is supported by the deuterium isotope effects found in this work. Salts of β-deuterio-esters were prepared and pyrolyzed at 180-240°. The mole fractions of deuterated olefins obtained on pyrolysis were determined by NMR spectroscopy. The deuterium isotope effect was 1.09 ± 0.17 for the 3-pentyl salt, 1.62 ± 0.23 for the 3-phenylpropyl salt and 2.09 ± 0.40 for the n-butyl salt. (Dissertation Abstr., 25: No. 4, Oct. 1964)

15552 APPLICATION OF INFRARED SPECTRA IN THE ANALYSIS OF YTTRIUM, DYSPROSIUM, AND YTTERBIUM ALKOXIDES. C. T. Lynch, K. S. Mazdiyasni, J. S. Smith, and W. J. Crawford (Air Force Materials Lab., Wright-Patterson AFB, Ohio). 13p. (CONF-571-30)

From American Chemical Society 148th National Meeting, Chicago.

The infrared absorption frequencies of Y, Dy, and Yb isopropoxides in the 5000 to 625 cm^{-1} region are tabulated and discussed. They indicate that the three isopropoxides have a dimer structure. Infrared absorption frequencies are also given for the 2-pentoxides of Y, Dy, and Yb and for the tert-butoxide of Y. The alkene-to-alkoxy alcoholysis reaction $Y(OC_3H_5)_3 + C_5H_{11}OH \rightarrow Y(OC_5H_{11})_3 + C_3H_5OH$ was studied using infrared spectra, and the results indicate a stepwise replacement of the alkene groups and the formation of an intermediate $Y(OC_5H_{11})_2(OC_3H_5)$. (D.L.C.)

Organic Chemistry

15553 (IDO-11401) ORGANIC COOLANT SUMMARY REPORT. R. F. Makens, ed. (Idaho Operations Office, Atomic Energy Commission, Idaho Falls). Dec. 1964. 480p. Dep.; $7.80(cy), 9(mn) CFSTI.

A summary is presented of the results of the development work on some aspects of organic coolant technology carried out in U.S. since 1955. Relevant work outside the U. S. is referenced in the text. Among the topics treated are properties of unirradiated and irradiated coolant, stability, coolant reclamation, improved coolants, film formation, dosimetry, reference compounds, and analytical methods. Separate abstracts were prepared for all ten chapters. (D.L.C.)

For abstracts of individual chapters see: 15345, 15554, 15555, 15566, 15567, 15568, 15569, 15858, 17277, and 17278.

15554 (IDO-11401(p.9-38)) PROPERTIES OF UNIRRADIATED COOLANTS. William C. Taylor (Combustion Engineering, Inc., Windsor, Conn.).

Data are given on the properties of the polyphenyl coolants: biphenyl, o-, m-, and p-terphenyl, and commercial mixtures of these four (Santowax series). The properties

include composition, impurities, solubility in solvents, physical properties, thermodynamic properties, and heat transfer. (D.L.C.)

15555 (IDO-11401(p.379-94)) REFERENCE COMPOUNDS. W. M. Hutchinson and R. C. Doss (Phillips Petroleum Co., Bartlesville, Okla.).

Reference compounds are needed to identify radiolysis products in degraded organic coolants. The preparation of such compounds is discussed. A table is presented of the reference compounds prepared in the U.S. Organic Reactor Program and Euratom Orgel Program; some of their properties and references to their preparation and spectra are also listed. (D.L.C.)

15556 THE STEREOCHEMISTRY OF TRITIUM SUBSTITUTION BY THE WILZBACH METHOD. II. THE DISTRIBUTION OF TRITIUM. S. J. Angyal, C. M. Fernandez, and J. L. Garnett (Univ. of New South Wales, Kensington, Australia). Australiar J. Chem., 18: 39-45(Jan. 1965).

When (–)-inositol was submitted to the Wilzbach labeling procedure, tritium-labeled myoinositol was formed as a by-product. It is shown by degradation that the (–)-inositol is labeled nearly at random, whereas all the tritium in the myoinositol is attached to the carbon atom on which the configurational inversion has occurred. (auth)

15557 KINETICS AND ISOTOPE EFFECT IN METHANOL SYNTHESIS AT LOW PRESSURES. Toyoyasu Saida and Atsumu Ozaki (Tokyo Inst. of Tech. and Toyo Gas Chemical Co., Tokyo). Bull. Chem. Soc. Japan, 37: 1817-21(Dec. 1964).

An investigation was made of the isotope effect in methanol synthesis. The work was carried out in the vicinity of atmospheric pressure with a reactant mixture of varying compositions. Hydrogen, deuterium, and carbon monoxide were used in the synthesis. Data are presented in tables and graphs. No isotope effect was observed in methanol formation, but one was observed in carbon dioxide formation in the process. (M.C.G.)

15558 RELATION BETWEEN THE CHEMICAL COMPOSITION AND THE DILUTION CAPACITY OF SCINTILLATION INHIBITORS IN LIQUID MEDIUM. Pierre Lerch and Maurice Cosandey. Helv. Chim. Acta, 47: 2417-21 (Oct. 12, 1964). (In French)

The effect of organic compounds, such as amines, chloride derivatives, acetates, and substituted benzenes, as scintillation inhibitors were studied, and an attempt was made to derive some general rules on the selection of solvents. The results showed that the dilution capacity of aliphatic organic substances is generally low and varies little with the length of the carbon chain. However, conjugation between nitro or carbonyl groups and the benzene ring produced significant dilution. (J.S.R.)

15559 THERMAL OXIDATION OF DEUTERATED POLYPROPYLENES. H. C. Beachell and D. L. Beck (Univ. of Delaware, Newark). J. Polymer Sci. Pt. A, 3: 457-68(Feb. 1965).

Some aspects of the thermal oxidation of deuterated isotactic polypropylenes are described. Several polymers of propylene, deuterated at different sites along the polymer chain, were subjected to a kinetic treatment designed to establish the comparative rates of oxidation at different temperatures. Infrared spectroscopy was used to follow the kinetics over the temperature interval 100 to 130°C. These experiments showed the existence of a deuterium isotope effect for the thermal oxidation of polypropylene. (auth)

15560 RATES OF ABSTRACTION OF HYDROGEN, DEUTERIUM, AND TRITIUM FROM ACETONE IN ALKALINE MEDIA. J. R. Jones (Battersea Coll. of Tech., London). Trans. Faraday Soc., 61: 95-9(Jan. 1965).

Measurements are reported on the kinetics of the base-catalyzed exchange of acetone, deuterated acetone, and tritiated acetone over a temperature range. The observed activation energies are in the expected order $E_T > E_D > E_H$, with the differences slightly higher than the maximum expected. Results using the species CD_3COCD_2T indicated a 5 to 10% secondary isotope effect. The deuteroxyl ion was 1.3 to 1.5 times as effective a base as the hydroxyl ion. Correlation of the K_H/K_D and K_H/K_T values using Swain's equation showed that the experimental values of K_H/K_T are considerably higher than predicted by theory. (auth)

Radiation Chemistry

See also BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstracts 15826, 15895, 16233, 16249, and 17333.

15561 (AD-605430) EFFECTS OF IONIZING RADIATION ON PYRIDINE. Carol K. Pearce (Army Electronics Labs., Fort Monmouth, N. J.). July 1964. 14p. $1.00. (CFSTI).

Irradiation of liquid pyridine was found to produce polypyridines, and hydrogen and acetylene gases. A mechanism is presented to explain the products and yields observed. Some conclusions related to the use of pyridine compounds for electronic devices are discussed. (auth)

15562 (AERE-R-4838) IRRADIATION OF CARBON DIOXIDE CONTAINING SMALL AMOUNTS OF METHANE. R. W. Hummel (Research Group, United Kingdom Atomic Energy Authority, Wantage (England)). Jan. 1965. 34p. Dep.; $1.00(BIS), 5s.(HMSO).

Carbon dioxide containing from 500 to 13,000 vpm of methane was irradiated with 4 Mev electrons and ^{60}Co gamma rays. Methane consumption and formation of H_2, CO, H_2O, and C_2H_6 were studied in closed bulb experiments. Some results were also obtained in a circulating-flow system at constant CH_4 concentration. Temperatures were varied from 17 to 500°C; pressures were mainly near atmospheric. G values are reported and possible reactions are discussed. (auth)

15563 (AFML-TR-64-353) THE RADIATION CHEMISTRY OF ACETYLENIC COMPOUNDS. R. E. Rondeau, L. A. Harrah, T. D. Nevitt, H. H. Barber, Jr., and R. Schaffer (American Oil Co., Whiting, Ind.). Oct. 1964. Contract AF33(616)-8247. 30p.

The distribution of products from the radiolysis of butyne-2, propyne, pentyne-2, hexyne-3, and butyne-1 are given. Dimers, trimers, and tetramers, of empirical formulas C_nH_{2n}, C_nH_{2n-2}, and C_nH_{2n-4}, are formed in the following relative concentration: [Dimers] ≫ [Trimers] ≫ [Tetramers]. A general mechanism on the basis of free radical reactions is invoked to account for this distribution. In addition, aromatic products are also formed. (auth)

15564 (BMI-1713) RADIATION-INDUCED FORMATION OF ORGANO-TIN COMPOUNDS. Allison F. Fentiman, Robert E. Wyant, Robert D. Steinmeyer, David A. Jeffrey, John F. Kircher, and E. Jack Kahler (Battelle Memorial Inst., Columbus, Ohio). Feb. 3, 1965. Contract W-7405-eng-92. 25p. Dep.; $0.75(cy), 1(mn) CFSTI.

Effects of variables on yield and product distribution were studied and yields corresponding to a G-value of ~200 were obtained in experiments with tin and 1-bromobutane under the best conditions. It was found that washing the tin 30 min in dilute hydrochloric or hydrobromic acid and maintaining a tin/halide ratio of 4.2 to 7 contributed to the achievement of high yields. Tin particle sizes from 20 to 200 mesh were studied. Increasing yield was obtained with decreasing particle size. Increasing dose up to $\sim 1 \times 10^6$ rads at 101°C increased the rate of product formation. The reaction had an activation energy of 35 kcal up to 90°C; above 90°C the activation energy became very small or perhaps zero. Although alkyl chlorides were less reactive than alkyl bromides, and alkyl chain length influenced yields, organotin formation via radiation inducement appeared to be general for alkyl halides. As part of this study, a method for the analysis of the reaction products from tin and 1-bromobutane by gas-liquid chromatography was developed. (auth)

15565 (BNL-841(p.43-51)) RADIATION DIVISION. B. Manowitz (Brookhaven National Lab., Upton, N. Y.).

Measurements were made of the degraded spectrum from a ^{60}Co source in a large three-segment, U-shaped duct, and analyzed by the unfolding technique. The investigation of the electrical discharge phenomena in glass was extended to other insulating materials. The gamma calorimeter was completed, calibrated, and used to measure the self-absorption and total activity of several high level ^{60}Co sources. Radiation-produced polyethylene was characterized and process variables further investigated. An apparently unique copolymer of ethylene and hexamethylcyclotrisiloxane was formed and studies are continuing on the characterization of ethylene-carbon monoxide copolymers. Experiments have continued on evaluating the products of the ^{60}Co gamma radiolysis of ammonia and on the decomposition of CO_2 on various solid substrates. In the program on chemonuclear reactors, the fabrication of the in-pile section of the chemonuclear loop is well under way. In the effort on chemonuclear fuel development, tests on radiation damage, aerodynamics behavior, and corrosion behavior of U-Pd alloy foils were performed. Capsule data in fission fragment radiolysis of O_2-N_2 mixtures were obtained. Information was extended on the ionic polymerization of styrene and in the conductance method for studying ionic polymerizations. A considerable amount of data was obtained in the radiolysis of deuterated toluenes. Radiolysis in solid solutions of acrylamide and propionamide showed hydrogen yield curves at temperatures below which polymerization occurs. This may be explained either by hydrogenation scavenging and/or by energy transfer. (N.W.R.)

15566 (IDO-11401(p.39-75)) RADIOLYTIC AND PYROLYTIC STABILITY. K. Lynn Hall (California Research Corp., Richmond).

A detailed summary is presented of the state of knowledge in June 1964 on the pyrolysis and radiolysis of polyphenyls. The variables involved are discussed. Organic coolant burnup and polymer formation are considered. Finally, possible mechanisms and interpretation of the data are discussed. (D.L.C.)

15567 (IDO-11401(p.77-173)) PHYSICAL AND CHEMICAL PROPERTIES OF IRRADIATED COOLANTS. Herman Mandel, Mary A. Rotheram, and Robert T. Keen (Atomics International, Canoga Park, Calif.).

The effects of the radioinduced high boiler fraction on the physical and chemical properties of polyphenyls are reviewed in detail. The physical properties include density, viscosity, specific heat, thermal conductivity, melting point, explosibility and combustibility, etc. The chemical properties include composition, free radicals, unsaturation, acid number, high boilers, impurities, activation, etc. (D.L.C.)

15568 (IDO-11401(p.175-226)) COOLANT RECLAMATION. John C. Hillyer (Phillips Petroleum Co., Bartlesville, Okla.).

A review is presented of research on the reclamation (reconversion) of high boilers in irradiated terphenyl and other polyphenyl coolants. The methods studied include physical methods (short-path distillations and solvent extraction) and chemical methods (catalytic hydrocracking, hydrogenation, etc.). The results show that catalytic hydrocracking is the most promising method. (D.L.C.)

15569 (IDO-11401(p.227-60)) IMPROVED ORGANIC COOLANTS. John C. Hillyer (Phillips Petroleum Co., Bartlesville, Okla.).

A survey is given of a coolant screening program in which new chemicals, stabilizers, and industrial products were evaluated. The processing of commercial fluids to produce cheap fluids of acceptable radiation resistance is discussed. (D.L.C.)

15570 (NAA-SR-8277) RADIOLYTIC AND PYROLYTIC DECOMPOSITION OF ORTHO TERPHENYL AT HIGH TEMPERATURE. J. M. Scarborough (Atomics International Canoga Park, Calif.). [1962]. Contract AT(11-1)-Gen-8]. 28p. Dep.; $0.50(cy), 1(mn) CFSTI.

The pyrolytic decomposition rates of ortho-terphenyl were determined at various temperatures between 750 and 900°F and the temperature dependence of the initial rates established. The formation rates for biphenyl in the pyrolysis of ortho-terphenyl were also determined. The radiolytic decomposition of ortho-terphenyl was studied in the same temperature range using 1.0 Mev electrons from a Van de Graaff generator. The temperature dependence of initial radiolytic decomposition rates was established. Comparisons were made between the pyrolytic and radiolytic behavior of ortho-terphenyl. (auth)

15571 (TID-21385) RADIATION STABILITY AND INORGANIC RADIOCHEMISTRY. [Progress Report]. G. T. Fisher and W. D. Threadgill (Vanderbilt Univ., Nashville, Tenn.). Sept. 30, 1964. Contract AT(40-1)-1327. 247p. Dep(mn); $6.00(cy), 5(mn) CFSTI.

An applied research program was conducted which involved a survey of the radiation stability of many materials under bombardment with high-intensity soft x-ray beams, gamma-ray beams, and radiation from used MTR fuel elements. Capacity changes and physical and chemical degradations of representative ion exchange resins, degradation and changes in distribution coefficients of solvents and solutes, the creation and destruction of ion complexes in solutions, and the continuous operation of purification equipment of interest in the field of separations chemistry were investigated. The mechanism of radiation decomposition of some of these materials was studied by a more detailed investigation of the kinetics and products of decomposition as a function of extent of radiation absorbed. Irradiations were investigated in liquid, gas, and solid phases, the gas phase irradiation being both with and without admixture of noble gases as energizing agents. (N.W.R.)

15572 (TID-21523) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Research Report for 1964. W. C. Sears (Georgia Univ., Athens. Dept. of Physics). Dec. 18, 1964. Contract AT(40-1)-2418. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

In this research program, the effects of gamma radiation on the molecular structure of various polymers are being studied using infrared spectra. The trans-vinylene growth in irradiated polyethylenes was studied, and the results were compared with these of other workers. The infrared spectra and crystallinity of DYNH and Marlex 50 polyethylenes before and after irradiation are discussed. The decrease of the trans-vinylene bands on melting is considered, and the production of trans-vinylene unsaturation by alpha and gamma rays is discussed. The amorphous and crystalline bands of Neoprene were identified, and the effects of irradiation were studied. (D.L.C.)

15573 (UJV-1138/64) TO THE ORIGIN OF THE E.S.R. SPECTRUM OF γ-IRRADIATED POLYMETHYLMETHACRYLATE. P. Kouřim and K. Vacek (Ústav Jaderného Výzkumu, Československá Akademie Věd, Řež (Czechoslovakia)). [1964]. 17p. Dep.(mn).

From the electron spin resonance spectra of γ-irradiated deuterated polymethylmethacrylates, conclusions were drawn supporting the interpretation of the spectrum of irradiated polymethylmethacrylate on the basis of a single free radical, viz. $-CH_2\dot{C}(CH_3)COOCH_3$. The evidence given excludes some views published formerly. (auth)

15574 (WL-TR-64-150) EFFECT OF ENVIRONMENTAL HYDROGEN PRESSURE ON THE HYDROGEN YIELD FROM X-IRRADIATED POLYETHYLENES. O. H. Hill and R. P. Lightfoot (General Dynamics/Fort Worth, Tex.). Jan. 1965. 37p. CFSTI.

An experimental assembly incorporating a capacitance-type, differential pressure transducer, which provides resolutions of 0.3 micron at pressures extending to 30 mm, was employed to monitor the effect of hydrogen environmental pressure on the hydrogen yield from x-irradiated polyethylenes. Contrary to the observations of previous researchers, the hydrogen yield is found to be independent of hydrogen environmental pressures extending up to at least 30 mm Hg. It is demonstrated that neglecting the

temperature and density gradients inherent in closed-volume irradiation assemblies employing cryogenic traps to separate liberated gases into condensable and noncondensable fractions may lead to erroneous conclusions with respect to gas yields arising from the irradiation of materials. Total volatile G-values of 3.6, 3.8, and 4.0 molecules per 100 ev were obtained for Marlex 6002, Dow Ziegler (Q 917.5), and DuPont A-1410 polyethylenes, respectively, with hydrogen contributions of approximately 98 mole percent. (auth)

15575 IONIZING RADIATION COLOR MEASUREMENTS OF THE HAP DOSIMETER. Majic S. Potsaid and Toshiji Umezawa (Massachusetts General Hospital, Boston). Am. J. Roentgenol., Radium Therapy Nucl. Med., 93: 715-24 (Mar. 1965).

A method for the measurement of direct quantitative relations between the intensity of induced color and the amount of radiation is presented. The solid in-phantom HAP dosimeter (Halogenated compound-Azo dye-Paraffin base) can be quantitatively analyzed for color changes as a function of radiation dose using photoelectric cell techniques. Reflectance and transmittance measurements of light intensity can be used. The relative transmittance technique is more sensitive and more practical. Log relative transmittance and extinction coefficients (sum of absorption and scatter coefficients) as a function of ionizing radiation dose, in general, display a graphic linearity. Isodose patterns obtained by measuring colors in irradiated HAP systems compared favorably with the standard curves for the same radiation quality. The central axis doses were in reasonably good agreement, but away from the midline there was a difference in the shape of the isodose contours for the two methods. (P.C.H.)

15576 THE EFFECTS OF CHEMICAL CONCENTRATIONS AND CHEMICAL MODIFIERS ON THE HAP DOSIMETER. Majic S. Potsaid and Toshiji Umezawa (Massachusetts General Hospital, Boston). Am. J. Roentgenol., Radium Therapy Nucl. Med., 93: 725-32(Mar. 1965).

Quantitative experimental data, effects of dye concentrations, and studies concerned with chemical agents modifying the behavior of the solid HAP dosimeter are discussed. The concentration of halogenated hydrocarbon shows a peak response to radiation that permits a favorable sensitivity in formulations approaching soft-tissue equivalence. The dye concentration influences the radioinduced color change but in a manner that is less significant. Alcohols stabilize the dosimeter color and in a few instances increase the dosimeter response to radiation. Phenols not only increase dosimeter sensitivity and prevent color fading but can eliminate the deleterious effects of trace amounts of water. At least one phenolic azo dye seems to have the most unusual property of influencing the HAP system differently for ionizing and non-ionizing electromagnetic radiation. (P.C.H.)

15577 PREPARATION OF CARRIER-FREE IODINE-131 FROM TELLURIC ACID BY IRRADIATION WITH NEUTRONS. J. Ortega Abellan. Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 535-40(July-Aug. 1964). (In Spanish)

A method for the preparation of ^{131}I is proposed; the method is based on the action of hydrogen peroxide, in strongly acid solution, to transform the different iodine oxidation states into elementary iodine, which is afterwards distilled off and collected into a diluted solution of NaOH. Concentrated phosphoric acid (85%; density 1.7) is used for dissolving the irradiated raw material (telluric acid); it is also within this acid that the transformation of the different iodine oxidation states into elementary iodine is carried out and where the iodine is distilled from. (auth)

15578 DETERMINATION OF ABSORPTION DOSES IN NEUTRON AND GAMMA IRRADIATION OF POLYMERS. F. A. Makhles and I. M. Kolpakov. At. Energ. (USSR), 18: 48-52(Jan. 1965). (In Russian)

Absorption doses for irradiation by fast and slow neutrons and γ irradiation of polymers (polyethylene, natural rubber, nitryl rubber, silicon rubber, Vaiton types of fluororubber, chaipalon, and teflon) and water were estimated considering the composition of the polymer and irradiation doses. (R.V.J.)

15579 RADIATION POLYMERIZATION OF METHYL METHACRYLATE IN SOLUTION. I. POLYMERIZATION IN ACETONE-BENZENE MIXTURE. J. Czajkowski, E. Turska, and J. Kroh (Technical Univ., Lodz, Poland and Lab. of Physical Chemistry of High Polymers, Polished Academy of Sciences, Lodz). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 795-800(1964).

Studies were made on the radioinduced polymerization of methyl methacrylate (MM) in acetone–benzene. Radioinduced polymerization of MM and of MM in acetone was found to proceed at the same rate. This may be ascribed to the similar values of radiation yields for MM and acetone. In benzene and in benzene–acetone, the rate of polymerization decreased. The influence of benzene was detected only for longer periods of irradiation, and most probably may be ascribed to the energy transfer $MM^* \rightarrow C_6H_6$. The influence of benzene was particularly marked in respect to the molecular weight of polymethyl methacrylate (PMM). (P.C.H.)

15580 RADIATION-INDUCED DEGRADATION OF POLYMETHYL METHACRYLATE IN SOLUTION. A. Polowinska, E. Turska, and J. Kroh (Lab. of Physical Chemistry of High Polymers, Polish Academy of Sciences, Lodz and Technical Univ., Lodz, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 801-4(1964).

Studies were made on the radioinduced degradation of polymethyl methacrylate (PMM) in acetone–benzene solution using ^{60}Co γ rays. The molecular weight of PMM was measured in order to establish the expected shielding effect of benzene. The results indicate that the lowest degradation effect was produced in an approximately equivolume acetone–benzene mixture. However, the influence of benzene was not very marked. It was concluded that under the conditions used, the size of macromolecular coils is independent of the solvent composition. Therefore the decrease in PMM degradation can be ascribed neither to the changes in the macromolecular shape nor to radical recombination. (P.C.H.)

15581 INFLUENCE OF IONIZING RADIATION ON THE COPOLYMERS OF METHYL METHACRYLATE AND STYRENE. SHIELDING EFFECT OF THE BENZENE RING. M. Walicki, E. Turska, and J. Kroh (Technical Univ., Lodz, Poland and Lab. of Physical Chemistry of High Polymers, Polish Academy of Sciences, Lodz). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 805-8 (1964).

The shielding effects of benzene on the irradiation of methyl methacrylate (MM) and styrene (s) copolymers were investigated. The concentration of peroxides or macroradicals was assumed to represent quantitatively the effects of radiation. The dependence of peroxide concentration on the concentration of styrene in copolymers irradiated in the presence of oxygen reached a maximum for low concentration of styrene. Measurements of intrinsic viscosity also showed that, for copolymers irradiated in the presence of oxygen, the relative decrease in intrinsic viscosity is the lowest for low styrene concentration. It was also found that in pure PMM irradiated in the presence of oxygen, peroxides are formed mostly as side groups, whereas in MM + S copolymers, peroxides may appear as well as fragments of the main chain. It was concluded that more adequate conditions for the investigation of the shielding action of benzene are reached in deaerated systems. (P.C.H.)

15582 THE PREPARATION OF PHOSPHORUS-32 IN A HIGH SPECIFIC ACTIVITY USING THE SZILARD-CHALMERS EFFECT. Kichizo Tanaka (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 37: 1730-3(Dec. 1964).

A process was developed for obtaining ^{32}P free from ^{33}P and with a high specific activity. The ^{32}P was prepared by an anion exchange method, in which a chloride solution containing 0.025M potassium chloride, 0.025M hydrochloric acid, and neutron-irradiated phosphate was passed through

the column of a strongly basic anion exchanger, and the adsorbed ^{32}P eluted with 8M hydrochloric acid. The anhydrous orthophosphate showed a good recovery compared with several orthophosphates, sodium orthophosphite, and sodium hypophosphite. The recovery was not much affected by the irradiation time. Enrichment factors higher than 10^3 were obtained. (auth)

15583 THE RADIOLYSIS OF LIQUID CIS-2-BUTENE. Yoshihiko Hatano, Shoji Shida, and Shin Sato (Tokyo Inst. of Tech.). Bull. Chem. Soc. Japan, 37: 1854-8(Dec. 1964).

The radiolysis of cis-2-butene was studied in the liquid phase at room temperature. The major products (and their G-values) were hydrogen (1.02), n-butane (0.83), 1-butene (0.40), trans-2-butene (2.29), C_8 hydrocarbons (2.30), and higher polymers. The G-values were independent of the total dose. Small amounts of $C_1 \sim C_3$ and $C_5 \sim C_7$ hydrocarbons were also formed. The hydrogen and the lower hydrocarbons except for n-butane were found, by using p-benzoquinone as a radical scavenger, to be produced for the most part through the molecular mechanism. The addition of benzene, naphthalene, and anthracene to liquid cis-butene had remarkable effects on the formation of trans-2-butene; thus, the cis-trans isomerization increased at a lower concentration of additives, while it decreased at a higher concentration of additives. The radical scavenging effect could not explain these results. From a comparison of the experimental results with ionization potentials and electron affinities of the aromatics, it was concluded that the increase in the isomerization at lower concentrations is due to the charge transfer from the butene to the additives. (auth)

15584 LIFE-TIME OF THE PROPAGATING RADICALS IN THE RADIATION-INDUCED TELOMERIZATION OF ETHYLENE WITH PROPANOL-2. Motoyoshi Hatada and Kozo Hirota (Japanese Assn. for Radiation on Polymers, Osaka and Osaka Univ.). Bull. Chem. Soc. Japan, 38: 26-8(Jan. 1965).

The radioinduced telomerization of an ethylene–propanol-2 mixture was investigated using electron beams. Both intermittent and steady irradiation methods were adopted in order to determine the lifetime of the chain-carrying radicals. In the sample irradiated, t-amyl alcohol could be identified, but the higher telomers found in previous experiments were not observed. The amount of telomer increased linearly with irradiation time. The yield was smaller than that obtained by gamma irradiation. The average lifetime of the radicals in the rate-determining step was estimated to be 0.01 sec by the rotating sector method. (M.C.G.)

15585 THE INFLUENCE OF pH ON MERCURIC CHLORIDE REDUCTION UNDER IONIZING RADIATIONS. P. Srinivasa Rao (Banaras Hindu Univ., Varanasi, India). Bull. Chem. Soc. Japan, 38: 137-8(Jan. 1965).

The influence of pH on the radioinduced reduction of the mercuric chloride-sodium oxalate system in the presence and absence of oxygen was studied. In aerated solutions, the yields of mercurous chloride diminished with decreasing pH values and at pH $\leq$ 1.9 the reduction was completely inhibited by ultraviolet radiation, at pH $\leq$ 1.78 by x radiation, and at pH $\leq$ 1.62 by 1-Mev electrons. In the presence of molecular hydrogen the reduction was not completely inhibited. (M.C.G.)

15586 TEMPERATURE EFFECT IN A RADIOLYTIC SYSTEM UNDER STEADY IRRADIATION. Kenji Fueki and John L. Magee (Nagoya Univ., Japan and Univ. of Notre Dame, Ind.). Bull. Chem. Soc. Japan, 38: 150-1(Jan. 1965).

The gross temperature effect in a system under irradiation is described. The average temperature rise, the time constant for approach to steady condition, and an effective rate constant in an irradiated system were estimated. As an example the relative temperature rise for liquid hydrocarbons was estimated as a function of dose rate and sample size. (M.C.G.)

15587 STUDY OF SZILARD-CHALMERS EFFECT ON DIETHYL-MERCURY AND DIPHENYL-MERCURY. Charles Heitz and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. France, No. 11, 2917-19(Nov. 1964). (In French)

Samples of diethylmercury and of diphenylmercury were irradiated in the pure state for 2 hrs in a thermal flux of 10^{12} neutrons $cm^{-2}sec^{-1}$. No isotopic effect was detected in the behavior of ^{203}Hg and ^{197m}Hg. The mean values of the retentions were 80 and 50% for diphenylmercury and diethylmercury, respectively. (tr-auth)

15588 ON THE FORMATION OF BENZO-3,4 PYRENE DURING THE COMBUSTION OF PREVIOUSLY IRRADIATED CIGARETTE PAPERS. Michel Hubert-Habart, Daniel Lavalette, and Raymond Latarjet (Universite, Paris). Bull. Soc. Chim. France, No. 11, 3033(Nov. 1964). (In French)

The effect of high doses of irradiation on the formation of cancerogenic hydrocarbons during the combustion of cigarette papers was investigated. The dry paper was exposed to ^{60}Co γ radiation at a dose rate of 10,000 r/min for a total dose of 1,000,000 r. The papers were burned and the smoke condensates were collected and analyzed. The results showed that the irradiation of dry paper at high doses did not affect the formation of benzo-3,4-pyrene during the combustion. (J.S.R.)

15589 THERMOLUMINESCENCE OF CALCIUM OXIDE EXCITED BY γ RAYS AT LOW TEMPERATURE. Joseph Janin and Laurent-Marcel Schwartz (Universite, Lyon). Compt. Rend., 259: 4597-4600(Dec. 21, 1964). (In French)

Thermoluminescent studies were made on calcium oxides excited by Pb, Mn, Sb, and Bi. The results showed that the levels of traps shown by luminescence after γ excitation also occur after excitation by ultraviolet radiation. The intensities of the thermoluminescence of CaO(Pb) were of the same order for both γ and ultraviolet excitation. The strong luminescence observed with γ rays for the samples activated by Mn, Sb, and Bi proved that the filling of the traps is quasi-total. (J.S.R.)

15590 STUDY AT 77°K OF THE TRAPPED NO_2 RADICAL IN AN IRRADIATED SINGLE CRYSTAL OF SODIUM NITRATE. Robert Adde (Faculte des Sciences, Orsay, France). Compt. Rend., 260: 504-7(Jan. 11, 1965). (In French)

In order to better define the state of the radical and to study the effect of the crystalline matrix, the paramagnetic electron resonance spectrum of the NO_2 radical trapped in irradiated $NaNO_3$ was studied at various temperatures, and the results obtained at 77°K are reported. The form of the spectra observed is described. Components of the q and k tensors were determined. The K tensor was decomposed, and the values were tabulated. The values of q were not appreciably affected by the matrix, but the variations of the hyperfine interaction constants were much more significant. The length of the ray of the radical in $NaNO_3$ varied from 3 to 4 gauss according to the crystal orientation. (J.S.R.)

15591 EFFECT OF γ RAYS ON DIHYDROURACIL IN AQUEOUS SOLUTION. Guy Vincendon, Andre Cier, and Claude Nofre (C.R.S.S.A., Lyon). Compt. Rend., 260: 711-13(Jan. 11, 1965). (In French)

The action of γ rays on 5,6-dihydrouracil in aqueous solution was studied in the presence and absence of oxygen. Among the products identified, the principal ones are barbituric acid, uracil, and 6-hydroxydihydrouracil, which gives evidence of a preferential attack on the 6 position. (tr-auth)

15592 CATALYTIC PROPERTIES OF RADIOACTIVE TUNGSTEN DISULFIDE IN THE n-DECYL ALCOHOL DEHYDRATION REACTION. Vikt. I. Spitsyn, V. I. Pikaeva, and I. E. Mikhailenko. Dokl. Akad. Nauk SSSR, 159: 1102-5(Dec. 11, 1964). (In Russian)

The yield of unsaturated hydrocarbons formed from n-decyl alcohol at 290 to 370°C increased with increasing ^{35}S content of the WS_2 catalyst from 0 to 9.0 to 96.6 mC/g. The yield of α isomer of the decene formed was also higher with the 9.0 mC/g catalyst than with the nonradioactive one. (IIC-M.G.)

15593 RADIATION STABILITY OF ALKALI METAL AZIDES TO γ RAYS. V. V. Boldyrev, A. N. Oblivantsev, and V. M. Lykhin. Dokl. Akad. Nauk SSSR, 159: 1113-16 (Dec. 11, 1964). (In Russian)

The radiation stability of alkali metal azides to γ rays and factors determining their stability were analyzed using recrystallized Na, K, Rb, and Cs azides irradiated by a dose of 2.9×10^{16} ev/ml sec at 35 to 40°C. The results showed that the radiation and thermal stabilities of azides do not coincide. The magnitude of the initial radiochemical decomposition yield of alkali azides increased linearly with the increase of the free volume in the crystalline azide elementary cell. (R.V.J.)

15594 THE RADIATION CHEMICAL LINKING OF POLYSTYRENE BY LINKING AGENTS. Z. A. Kostylyova, K. A. Kornyev, A. A. Kachan, L. L. Chervyatsova, and Z. N. Pazenko. Dopovidi Akad. Nauk Ukr. SSR, No. 1, 64-6(1965). (In Ukrainian)

The efficacy of using triallyl isocyanurate (TAIC) in radiochemical crosslinking of polystyrene was established. It is shown that polystyrene is practically completely linked on adding 20% TAIC and irradiating in air with a dose of 50 megarads. The crosslinked polymer retained a highly elastic state up to a temperature of >300°C. (auth)

15595 NEW ASPECTS AND PROBLEMS IN APPLICATION OF POWERFUL RADIOACTIVE SOURCE IN INDUSTRY. T. Gote. Genshiryoku Kogyo, 10: No. 3, 7-20(1964). (In Japanese)

In the Dow process, liquid $BrCH_2-CH_3$ is formed by ^{60}Co gamma irradiation, at 38.4°C, of a gaseous mixture of $CH_2=CH_2$ + HBr. Decomposition is small, reaction conditions are simple, and temperatures and pressures are low. In laboratory studies in nickel apparatus $^1/_{10}$ of industrial scale, with a 600-C dose at 19°C and no recirculation, conversion was 98–100%. When a stainless steel recirculating system was added, it was corroded. In nickel-plated stainless steel, conversion was 90%. The 40-gal reaction column of the nickel industrial equipment is located in a concrete pit, 4 ft underground and the 1800-C ^{60}Co source is in the center of the pit. Production (10^6 lb/yr) is considerably cheaper than in the catalytic process. In the gas-phase radiation polymerization of ethylene, G values are low because of the presence of O_2. Since the temperature is lower than the polyethylene melting point, the product is a solid, which is a disadvantage in an industrial process. The theoretical basis of the reaction was examined in some detail, along with dose distribution, apparatus construction, and economics. (IIC-MG)

15596 THE DIRECT ANALYSIS OF THE GASEOUS PRODUCTS FROM THE RADIOLYSIS OF LIQUID HYDROCARBONS. D. A. Jeffrey and J. F. Kircher (Battelle Memorial Inst., Columbus, Ohio). Intern. J. Appl. Radiation Isotopes, 16: 58-60(Jan. 1965).

The radiation chemistry of cyclopentanone was investigated by a direct gas chromatographic technique in an attempt to develop a routine method for the direct analysis of the gaseous products from the radiolysis of liquid hydrocarbons. All irradiations were carried out in a ^{60}Co source at ambient pool temperature. Data on the gaseous products formed are plotted and on the effects of additives on radiolysis products are tabulated. The direct gas chromatographic technique was found to be a reliable method for the analysis of the gaseous products formed in the radiolysis of organic substances even when present in relatively low concentration. Its use was further demonstrated in the presence of excess additives. (P.C.H.)

15597 MEASUREMENT OF ABSORBED DOSE OF MIXED-PILE RADIATION IN AQUEOUS RADIATION CHEMISTRY. I. G. Draganic, B. B. Radak, and V. M. Markovic (Inst. of Nuclear Sciences, "Boris Kidrich," Vinca, Yugoslavia). Intern. J. Appl. Radiation Isotopes, 16: 145-52 (Mar. 1965).

The problem of the measurement of the dose absorbed from mixed-pile radiations in aqueous radiation chemistry was studied and the application of a calorimetric and chemical system was considered in detail. The differential calorimeter described here permits simultaneous measurements of energy absorption in different materials. From these values it is possible to calculate the relative contributions of gammas and non-thermal neutrons to the total absorbed dose. The possibility of inserting a liquid sample into the calorimeter facilitates radiation chemical studies of aqueous solutions or, in general, liquid systems. The chemical system is oxalic acid in light- and heavy water solutions. The radiation chemical yields were measured under different working conditions. The possibility of using this chemical system for deriving relative contributions of different radiation components to the total absorbed dose is discussed. (auth)

15598 THE INFLUENCE OF FERROUS IONS ON THE RADIATION-CHEMICAL CARBOXYLATION OF AQUEOUS FORMIC ACID SOLUTIONS SATURATED WITH CO_2. F. Guetlbauer and N. Getoff (Inst. for Radium Research and Nuclear Physics, Vienna). Intern. J. Appl. Radiation Isotopes, 16: 199-209(Mar. 1965). (In German)

The effect of the ferrous ions in carboxylating formic acid was studied thoroughly in aqueous CO_2-saturated solutions (pH = 2.8) under the influence of ^{60}Co γ radiation. As was expected, an increase of the yield of the oxalic acid formed from $G_A(COOH)_2 = 1.8$ without ferrous ions to $G_A(COOH)_2 = 5.3$ in presence of 10^{-3} m $FeSO_4$ and to $G_A(COOH)_2 = 6.6$ in 10^{-2} m $FeSO_4$ solutions, respectively was observed. The formation of the oxalic acid was investigated in its dependence on the radiation dose, on the absorbed dose rate, and on the concentration of the ferrous ions. The influence of the ferrous ions in radiation chemical carboxylations is of rather a complex nature. On one hand they remove the oxidizing primary products of the radiolysis of water and thus suppress the decomposition of the oxalic acid. On the other hand, being electron donors they initiate an additional formation of solvated electrons or (CO_2^-)-radical ions, respectively. To explain the experimental results the most plausible reaction mechanisms are cited. (auth)

15599 MASS-SPECTROMETRIC ANALYSIS OF THE DECOMPOSITION PRODUCTS OF GAMMA-IRRADIATED POTASSIUM SODIUM TARTRATE. S. Azizov (Inst. of Physics and Tech., Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 90-2(1964). (In Russian)

The gaseous decomposition products of gamma irradiated Rochelle salt were studied qualitatively and quantitatively in a mass spectrometer under conditions such that the proportionality between the partial pressure of each component and the intensity of each peak was maintained. The energy of the ionizing electrons was 45 ev, pressure in the chamber was 1×10^{-6} mm Hg, and at the source 3×10^{-6} mm Hg. Crushed samples of the salt were placed in evacuated molybdenum-glass ampoules, pressure 0.01 mm Hg, and subjected to gamma rays at 0.5×10^6 Roentgen/hr. Irradiated ampoules were exhausted into a 2200 cc gas volume connected to a mass spectrometer. The gas volume was connected to both MacLeod and U-type manometers for measurement of pressure. When the gas volume was evacuated to 0.001 mm Hg, the ampoule was connected to the gas volume and gas pressure was measured. Mass spectrometric analysis showed lines with mass numbers 2(H_2^+), 16(CH_4^+ and possibly O^+), 17(OH^+), 18(H_2O^+), 28(CO^+ and traces of atmospheric N_2), 32(O_2^+), 43(unknown), 44(CO_2^+), and 45(possibly $C^{13}O_2^+$), with water vapor, carbon dioxide, carbon monoxide, and methane predominant, in that order. A 4-g sample irradiated with 40×10^6 R produced correspondingly greater numbers of molecules of the decomposition products than a nonirradiated sample. It is also probable that a significant change in crystal structure occurred, since changes in microscopic hardness and other quantities were indicated. (OTS)

15600 EXAMINATION BY INFRARED ABSORPTION SPECTRA OF THE CHANGES IN POLYETHYLENE IRRADIATED IN THE IRT-1000 NUCLEAR REACTOR, SOFIA. P. Kircheva, K. Nikolov, and P. Simova. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 31-8(1964). (In Russian)

Infrared absorption spectra of polyethylene irradiated by a mixed pile radiation are reported. Certain new frequencies were established, appearing in the spectrum as a result of chemical changes. The disappearance of two frequencies related to the polyethylene crystal phase was also established. A method is suggested for determining the polyethylene crystal phase concentration by means of the doublet 720–730 cm^{-1}, which remains unaffected by radiation chemical changes in polyethylene. An attempt was made to separate the action of fast neutrons in the mixed neutron flow. (auth)

15601 THE RADIOLYSIS OF 1,4-CYCLOHEXADIENE AND 1,4-CYCLOHEXADIENE-$^{14}CH_3I$ MIXTURES. Manfred K. Eberhardt, George W. Klein, and Thomas G. Krivak (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 87: 696-8 (Feb. 20, 1965). (RRL-148)

The radiolysis of 1,4-cyclohexadiene was studied in order to provide information about the reactions of cyclohexadienyl radicals. The disproportionation of cyclohexadienyl radical, produced by radiolysis of 1,4-cyclohexadiene, yielded 1,4-cyclohexadiene, 1,3-cyclohexadiene, and benzene in a ratio of 2.74 : 1.0 : 3.74. In scavenging experiments with small amounts of $^{14}CH_3I$ (0.11 mole %) the two methylcyclohexadienes (I and II) were formed in a ratio of 1.6 ± 0.3. The mechanisms of a chain isomerization to 1,3-cyclohexadiene, which was observed in the radiolysis of 1,4-cyclohexadiene-$^{14}CH_3I$ mixtures, is discussed. (auth)

15602 DIRECT OBSERVATION OF THE CHARGE NEUTRALIZATION REACTION IN A GAMMA-IRRADIATED ORGANIC GLASSY SOLID. Kenji Fueki and Zen'ichiro Kuri (Nagoya Univ., Japan). J. Am. Chem. Soc., 87: 923-4 (Feb. 20, 1965).

The charge neutralization processes in both pure 3-methylpentane and a mixture of 3-methylpentane and vinyl acetate, gamma-irradiated at 77°K, were observed, using the electron spin resonance technique. The electron spin resonance spectra are shown and a mechanism for charge neutralization proposed. (M.C.G.)

15603 EFFECTS OF IONIZING RADIATIONS ON FATS. II. ACCUMULATION OF PEROXIDES AND OTHER CHEMICAL CHANGES. J. R. Chipault and G. R. Mizuno (Hormel Inst., Austin, Minn.). J. Am. Oil Chemists' Soc., 41: 468-73(July 1964).

Chemical changes induced by γ irradiation of pure fatty acid methyl esters were studied. Irradiation and storage of irradiated methyl myristate under vacuum resulted in formation of small quantities of these compounds. Irradiation under oxygen gave peroxides and carbonyl compounds in yields indicating that every ionization results in the formation of one molecule of each group, and antioxidants had no effect on the formation of these compounds during irradiation. Irradiation of methyl linoleate under vacuum resulted in destruction of preformed hydroperoxides. During irradiation in oxygen, ~⅛ of the peroxides formed arose from the direct reaction of irradiation-induced free radicals with oxygen, while the rest were formed through a chain mechanism with an average chain length of 7. Peroxides continued to accumulate in irradiated methyl linoleate stored under oxygen at a rate increasing with initial irradiation dose. Antioxidants had some effect in retarding the formation of peroxides during irradiation of methyl linoleate and during postirradiation storage, but the effect was small compared to their antioxygenic activity toward simple autoxidation. The effect varied with the nature of the antioxidant and with irradiation dose. Propyl gallate was much less effective than butylated hydroxyanisole (BHA) and appeared to be easily destroyed during irradiation. BHA remained effective after irradiation and a concentration of 0.01% was more than adequate to counteract the pro-oxidant effect of a dose of 4.65×10^6 rad. Citric acid further enhanced this effect when added with BHA at a concentration of 0.01%. (TCO)

15604 EFFECT OF IMPURITIES ON THE HARDENING AND COLORATION OF KCl IRRADIATED AT ROOM TEMPERATURE. W. A. Sibley and J. R. Russell (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 36: 810-15(Mar. 1965). (ORNL-P-336).

Measurements of flow stress and F-band coloration were made at room temperature on a number of "pure" and impurity-doped KCl crystals as a function of gamma and electron irradiation. As has been observed, the flow stress increase, for late-stage coloration, is proportional to the square root of the F-band absorption. However, it is found that the early-stage coloration does not contribute to the radiation hardening. These results suggest that the late-stage production mechanism for F centers involves interstitial formation and clustering, whereas no stable interstitials are formed during early-stage coloration. Moreover, even though it is known that certain impurities enhance early-stage coloration, it is found that the concentration of early-stage F centers is only a small percentage of the total impurity concentration. This suggests that only isolated positive-ion vacancies are involved in the F-center production mechanism for this stage. (auth)

15605 EFFECTS OF 40-Mev ALPHA PARTICLES ON DISLOCATIONS IN SODIUM CHLORIDE. Michael Hacskaylo (Melpar, Inc., Falls Church, Va.). J. Appl. Phys., 36: 855-6(Mar. 1965).

Crystals of NaCl were annealed, bombarded with 40-Mev alpha particles to various exposures, and cleaned in a plane parallel to the direction of the alpha beam. The cleaned surfaces were etched with Muran solution, and the density and distribution of the etch pits were studied. (D.C.W.)

15606 STIMULATED EMISSION IN AN EUROPIUM CHELATE SOLUTION AT ROOM TEMPERATURE. Erhard J. Schimitschek, John A. Trias, and Richard B. Nehrich, Jr. (Naval Electronics Lab., San Diego, Calif.). J. Appl. Phys., 36: 867-8(Mar. 1965).

Laser emission at 6118Å was obtained in a solution of a europium–benzoyltrifluoroacetone-pyrrolidine complex in acetonitrile. The threshold pump energy was studied as a function of the concentration and temperature. (D.C.W.)

15607 IRRADIATION DAMAGE IN TYPE I DIAMOND. H. B. Dyer and L. du Preez (Diamond Research Lab., Johannesburg). J. Chem. Phys., 42: 1898-1906(Mar. 15, 1965).

In addition to the GRI and uv bands induced in all diamond by 0.78-Mev electron irradiation, another optical absorption feature, which was named the ND1 band, was found in all Type I diamonds. A single EPR line appeared to be associated with the ND1 band. It is suggested that the ND1 center arises from the combination of a defect product, probably an interstitial, and nitrogen in platelet form. Certain observations can only be explained by assuming that the ND1 centers are not distributed randomly through the crystal, but occur in clusters. The ND1 center acts as an acceptor, the center (probably a vacancy) responsible for the GRI and uv band as a donor. In the ionized state, GRI is optically inactive; ND1 is optically active. Electron transfer by thermal excitation results in the bleaching of GRI and enhancement of ND1. Illumination with light in the ND1 band causes electron transfer in the reverse direction, restoring band strengths to their former condition. A model is proposed, which defines the energies within the forbidden gap of the ground and excited states of GRI and ND1. (auth)

15608 MASS-SPECTROMETRIC STUDY OF PHOTOIONIZATION. II. H_2, HD, AND D_2. Vernon H. Dibeler, Robert M. Reese, and Morris Krauss (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 2045-8(Mar. 15, 1965).

Mass-spectrometric techniques were used to obtain photoionization efficiency curves for H_2, HD, and D_2 in the energy range from 815 to 700 Å (15.2 to 17.7 ev). A qualitative description of the observed autoionization process, based on a theory proposed by Fano, was applied to an analysis of the results. (auth)

15609 EFFECT OF ELECTRIC FIELDS ON THE RADIATION-INDUCED REACTION BETWEEN CARBON DIOXIDE AND GRAPHITE. Tsutomu Watanabe (Japan Atomic Energy Research Inst., Tokyo), Hisao Matsumura,

Masamitsu Washino, and Makoto Natori. J. Chem. Phys., 42: 2154-8(Mar. 15, 1965).

The effect of an electric field on the γ-induced reaction of CO formation from CO_2 and graphite was investigated. The experiment was carried out at room temperature under an exposure dose rate of 1.5×10^5 r/hr using diodelike tubes with graphite and metal (tungsten or molybdenum) electrodes filled with CO_2 gas at 300 mm Hg. When a negative voltage was applied to the graphite to obtain a saturation current, the yield of CO was about 2.5 times as much as that in the absence of any field. However, on application of a positive field, the yield was not significantly different than the zero field case. The G value for CO formation was found to be 0.62 to 1.01 in the absence of the field. The ionic reaction mechanisms $CO_2 + C^-$(graphite electrode) → 2CO and/or $CO_2^+ + C^-$(graphite electrode) → C(graphite)O + CO are proposed for the increased yield of CO in the case of negative voltage application to the graphite. (auth)

15610 PREPARATION OF CARRIER-FREE SODIUM-24 BY $^{24}Mg(n,p)^{24}Na$ AND $^{27}Al(n,\alpha)^{24}Na$ REACTIONS. Kee-chuan Pan, Yi-der Chen, Hwei-kwan Hong, and Chau-ting Chang (National Tsing Hua Univ., [China]). J. Chinese Chem. Soc. (Taiwan), 11: 135-42(Sept. 1964).

Carrier-free ^{24}Na was prepared by bombardment of magnesium carbonate and aluminum foil with fast neutrons produced by the Tsing Hua Open Pool Reactor. The induced nuclear reactions were $^{24}Mg(n,p)^{24}Na$ and $^{27}Al(n,\alpha)^{24}Na$, respectively. The separation of the isotope was carried out by leaching, precipitation, solvent extraction, and ion exchange. For each separation method used, the chemical yield and decontamination factor were determined and compared. It was found that ion exchange column operation was the most satisfactory method. (auth)

15611 THE BEHAVIOUR OF RADIOIODINE IN TeO_2. J. Stevovic, Lj. Jacimovic, and S. R. Veljkovic (Institute "Boris Kidrich" and Faculty of Science, Belgrade). J. Inorg. Nucl. Chem., 27: 29-32(Jan. 1965).

Radioiodine ^{131}I was produced by neutron irradiation of TeO_2. The distribution of valency forms was studied, mainly as two groups: reduced forms containing $I_2 + I^-$ and oxidized forms containing $IO_3^- + IO_4^-$. Their separation was carried out using ion-exchange techniques. The effect of length of irradiation on the distribution of those forms was found. The percentage of reduced forms increased with increasing integral neutron flux. The same type of the change was found when TeO_2 was heated after the irradiations. That phenomenon was radically different from the corresponding results for solid iodates. Possible interactions with the target material are suggested, which are primarily chemical in nature, and depend on the isotopic relations of the components. (auth)

15612 THE RADIATION-INDUCED ADDITION REACTION OF ETHERS TO 1,2-DICHLOROTETRAFLUOROCYCLOBUTENE AND 1,2-DICHLOROHEXAFLUOROCYCLOPENTENE. Hiroshige Muramatsu and Kan Inukai (Government Industrial Research Inst., Nagoya, Japan). J. Org. Chem., 30: 544-7(Feb. 1965).

The addition reactions of tetrahydrofuran, dioxane, and diethyl ether to 1,2-dichlorotetrafluorocyclobutene and 1,2-dichlorohexafluorocyclopentene were carried out under gamma irradiation. Though the addition of tetrahydrofuran to 1,2-dichlorotetrafluorocyclobutene gave only the 1:1 adduct in an excellent yield, the addition of dioxane yielded mainly the dehydrochlorinated 1:1 adduct, 2-(2-chlorotetrafluoro-1-cyclobutenyl)-dioxane, along with the 1:1 adduct. In the case of diethyl ether, both the dehydrochlorinated 1:1 and 1:2 adducts, α-(2-chlorotetrafluoro-1-cyclobutenyl)diethyl ether and α-(1,2-dichlorotetrafluorocyclobutyl)-α'-(2-chlorotetrafluoro-1-cyclobutenyl) diethyl ether, were formed along with the 1:1 and 1:2 adducts. In the addition of the ethers to 1,2-dichlorohexafluorocyclobutene, only the corresponding dehydrochlorinated 1:1 adducts were obtained. (auth)

15613 GEL FORMATION IN POLYOLEFINS EXPOSED TO IONIZING RADIATION. B. J. Lyons (Raychem Corp., Redwood City, Calif.). J. Polymer Sci. Pt. A, 3: 777-91 (Feb. 1965).

It is shown that a resonable value for the ratio of main chain scission to crosslinking rates in a number of polyolefins at infinite dose is close to zero. The sum of the sol fraction (s) and its square root ($\sqrt{s}$) in almost all of the polymers studied was proportional to some fractional power of reciprocal dose. There was some evidence to suggest that $s + \sqrt{s}$ in relatively low molecular weight polyolefins, which initially contain small amounts of reactive carbon–carbon unsaturation and have random distributions, may be proportional to the square root of the reciprocal dose. There is already good evidence that main chain scission rates in polypropylene and poly-1-pentene decrease with increasing dose: such a variation may account for the observed relationship in these polymers and presumably also in polyethylene. Another possible explanation is that the chance of a molecule becoming attached to the crosslinked network depends not only on the number of monomer units it contains, but also on the chance that a previous radiation event (such as trans-vinylene formation) has already occurred in that molecule. (auth)

15614 PHOTOINDUCED POLYMERIZATION OF β-PROPIOLACTONE IN THE PRESENCE OF URANYL NITRATE AS A SENSITIZER. M. Sakamoto, K. Hayashi, and S. Okamura (Japanese Assn. for Radiation Research on Polymers, Osaka). J. Polymer Sci.; Pt. B, 3: 205-7(Mar. 1965).

The photoinduced polymerization of lactones sensitized by uranyl nitrate is reported. The rate of polymerization was followed gravimetrically using methanol as a precipitant. In the presence of uranyl nitrate, the polymerization of β-propiolactone proceeded at a considerably high rate under irradiation with light of a wavelength shorter than 5000 Å. The apparent activation energy was calculated to be 18 kcal/mole. The polymerization was inhibited by both radical scavengers and compounds that break down the formation of the molecular complex. (M.C.G.)

15615 STUDY OF ELECTRON SPIN RESONANCE FOR THE PURPOSE OF PROTECTING COMPOUNDS CONTAINING SULFUR AGAINST THE EFFECTS OF IONIZING RADIATIONS. Wen-gen Hsi, Men-jin You, Chung-Ien Chang, and Kuang-Hsien Huo. K'o Hsueh T'ung Pao, No. 12, 1105-7 (1964). (In Chinese)

Continuing the studies of A. Norman et al., W. Gordy et al., and T. Henriksen et al., the electron spin resonance spectrum of S-containing compounds in amino acids and proteins exposed to ionizing radiation was measured. The material used for the experiments consisted of a molecular mixture with a ratio of 2:1 of the S-containing compound to the amino acid and 1:9 of the S-containing compound to the protein (by weight). The mixture was dissolved in distilled water and vacuum-dried at −15°C and was exposed to γ radiation from a ^{60}Co source at a dose rate of 260 to 270 r/sec for a total dose of 10^6 rem. The results indicated that a molecular mixture of a S-containing compound with a small amount of amino acid is able to change markedly the resonance spectrum of the protein; this effect was not observed in the case of a simple mechanical admixture. Thus the S-containing compound is able to affect the free radical of the protein and the amino acid exposed to ionizing radiation. This behavior can be explained by assuming that in a molecular mixture the S-containing compound, the amino acid, and the protein possess certain links. The spectrum change is due to a shift of the unpaired electron of the protein and the amino acid. The hydrogen shift also may be a responsible factor. (TTT)

15616 RADIATION-INDUCED CYCLOPOLYMERIZATION OF ACRYLIC ANHYDRIDE. Mitsuo Okada, Kanae Hayashi, Koichiro Hayashi, and Seizo Okamura. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 95-103 (1963-64). (In Japanese)

Radiation-induced solution and bulk polymerization of acrylic anhydride were carried out over a wide range of temperature in order to study the effects of temperature, phase, conversion, and initial monomer concentration on the degree of cyclization of the polymer obtained. The degree of cyclization increased with increasing conversion and temperature, and decreased with increasing initial

monomer concentration. The degree of cyclization of the polymer formed in solid state at −78°C was similar to that of the polymer obtained in toluene solution at the same temperature. But the polymer formed in solid state was crosslinked. Determination of the residual unsaturation of the polymer by bromometry made it possible to evaluate the ratio k_c/k_p of the rate constant of vinyl propagation and that of cyclization; for solution polymerization in toluene at 30°C, this ratio was equal to 0.09. Similarly, the difference between the activation energies of vinyl propagation and cyclization was evaluated to be 2.3 kcal/mole for solution polymerization in toluene, and 4.7 kcal/mole for bulk polymerization in the liquid state, respectively. (auth)

15617 SOLID STATE COPOLYMERIZATION OF MALEIC ANHYDRIDE AND ACENAPHTHYLENE INDUCED BY IONIZING RADIATION. Akira Shimizu, Koichiro Hayashi, and Seizo Okamura. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 129-38(1963-64). (In Japanese)

Radioinduced solid-state polymerization in the system of maleic anhydride and acenaphthylene was carried out for the purpose of studying the solid-state polymerization of vinyl compounds in binary systems. By melting-point measurement and differential thermal analysis, it was confirmed that the binary monomer system forms a eutectic mixture in the solid state. In solid-state polymerization these monomers had a maximum polymerization rate at the eutectic composition, and the polymerization products were a mixture of polyacenaphthylene and 1:1 maleic anhydride-acenaphthylene copolymer. Since in solution polymerization 1:1 copolymer was also obtained, it was considered that solid-state copolymerization of maleic anhydride and acenaphthylene occurred in a liquid-like state at the boundary of two monomers. (auth)

15618 POLYMERIZATION OF CYCLIC ETHERS IN THE PRESENCE OF MALEIC ANHYDRIDE. I. RADIATION AND ULTRAVIOLET LIGHT INDUCED POLYMERIZATIONS OF TRIOXANE AND 3,3-BIS(CHLOROMETHYL)OXETANE IN THE LIQUID STATE. Koichi Takakura, Koichiro Hayashi, and Seizo Okamura. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 139-47(1963-64).

Polymerization of trioxane and 3,3-bis(chloromethyl)-oxetane by gamma and ultraviolet radiation was studied. Effects of maleic anhydride were determined. Data are presented in graphs. The maleic anhydride was found to markedly accelerate the polymerization. (M.C.G.)

15619 ANION RADICAL AS AN INTERMEDIATE IN THE RADIATION-INDUCED POLYMERIZATION OF α-METHYLSTYRENE. Kozo Hirota and Meiseki Katayama. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 205-14(1963-64). (In Japanese)

Gamma-induced polymerization of α-methylstyrene was studied with sodium-dried monomer, and a G(-monomer) value as high as 36,500 was obtained. Though inhibition of the reaction by DPPH and the absence of co-polymer in the isobutylene mixture and the radical mechanism hitherto proposed was explained, a more satisfactory interpretation of the data was reached by postulating an anion radical as a reaction intermediate. The effect of solid additives and the significance of irradiation with a high dose rate were also investigated. (auth)

15620 PHOTO-INDUCED CHANGE OF ORGANIC FREE RADICALS AS STUDIED BY ESR. V. CONVERSION OF THE α-CYCLOHEXANOL RADICAL TO THE β-CYCLOHEXANOL RADICAL IN IRRADIATED CYCLOHEXANOL. Isamu Nitta, Shun-ichi Ohnishi, Tadayuki Ohmae, and Hiroshi Sakurai (Osaka Univ.). Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 221-3(1963-64).

Photoinduced conversion of the α-alcohol-type radical to means of electron spin resonance (ESR) spectroscopy. When cyclohexanol was irradiated to a dose of 10 Mrad at −196°C with an electron beam from a Van de Graaff accelerator, a nine-line spectrum was obtained. Upon illumination with a high-pressure mercury lamp at −196°C, the spectrum gradually changed to a six-line one. This indicated a shift from the α-cyclohexanol radical to the β-cyclohexanol radical. (M.C.G.)

15621 PHOTO-INDUCED CHANGE OF ORGANIC FREE RADICALS AS STUDIED BY ESR. VI. CONVERSION OF THE α-CYCLOBUTANOL RADICAL TO THE β-CYCLOBUTOXY RADICAL IN IRRADIATED CYCLOBUTANOL. Isamu Nitta, Shun-ichi Ohnishi, Tadayuki Ohmae, and Hiroshi Sakurai. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 5: 225-7(1963-64).

Photoinduced conversion of the α-cyclobutanol radical to the cyclobutoxy one was found for irradiated cyclobutanol. Electron-beam irradiation was followed by exposure to ultraviolet radiation. (M.C.G.)

15622 ELECTRON SPIN RESONANCE STUDY OF RADICAL PAIRS TRAPPED IN IRRADIATED SINGLE CRYSTALS OF DIMETHYLGLYOXIME AT LIQUID NITROGEN TEMPERATURE. Yukio Kurita (Toyo Rayon Co., Ltd., Tebiro Kamakurashi, Japan). Nippon Kagaku Zasshi, 85: 833-42(Dec. 1964). (In Japanese)

The ESR (electron spin resonance) spectra of single crystals of dimethylglyoxime irradiated with x rays at 77°K were measured at the same temperature for various orientations of the crystals in the magnetic field. Analysis of the spectra revealed that two paramagnetic species are produced by the irradiation. One is an iminoxy radical $C(CH_3) \cdot NOH-C(CH_3)NO$ (M), which is stable at room temperature. The other, unstable at room temperature, is a radical pair containing two coupling nitrogen nuclei with principal values of the coupling constants of 52, 26, and 26 gauss, and 38, 22, and 22 gauss, respectively. The average distance between the two unpaired electrons was calculated to be 5.6 Å from principal values of the electron-electron coupling constant of 310, −155, and −155 gauss. The absorption corresponding to the $\Delta M = 2$ transition of the radical pair was observed in polycrystalline samples. The radical pair was tentatively identified to be the one consisting of two adjacent radicals M ··· M along the crystallographic a-axis. A simple theory of ESR of a radical pair with hyperfine structure was developed. (auth)

15623 OXIDATION BEHAVIOR OF PYRIDINE ADSORPED ON THE SURFACE OF SYNTHETIC ZEOLITE IRRADIATED WITH γ-RAY OF LARGE DOSAGE. Daisei Yamamoto (Kumamoto Univ., Kumamoto-shi, Japan). Nippon Kagaku Zasshi, 85: 909-10(Dec. 1964). (In Japanese)

Powdered synthetic zeolite ("Molecular Sieve 3A & 13X") was dehydrated by heating at 300°C, then was sealed in the test tube with calcium chloride. The tube was brought into a field of powerful γ radiation and irradiated to the total dose of 1.1×10^9r. After the irradiated powder was impregnated with pyridine, differential thermal analysis was applied using the impregnated sample for studying the influence of the radiation on the combustion behavior of pyridine adsorped on the surface of the irradiated zeolite in comparison with the standard differential curve of pyridine on not irradiated zeolite. The curves indicated that the radiation enhanced the adsorption of pyridine on both 3A and 13X. (auth)

15624 ON THE RADIOLUMINESCENCE OF ORGANIC SUBSTANCES. V. KINETICS OF THE LUMINESCENCE OF SOLUTIONS OF CERTAIN COMPOUNDS IN HEPTANE, NONANE, CYCLOHEXANE, AND DIOXANE. S. F. Kilin and I. M. Rozman. Opt. Spectry. (USSR) (English Transl.), 17: 380-3(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 705-11(Nov. 1964).

Results are given of the measurement of the luminescence yield and duration as a function of the concentration of the luminescent compound. The luminescence was excited by an ionizing radiation and by light in the absorption band of the dissolved materials. The yield of radioluminescence in paraffins was half of the yield in toluene. The duration of the radioluminescence in paraffins was the same as the duration of the fluorescence of the dissolved material (with a precision of $\pm 2 \times 10^{-10}$ sec). The excitation transfer mechanism in paraffins is discussed. (auth)

15625 ON THE EFFECT OF PLASTIC DEFORMATION ON THE LUMINOUS EFFICIENCY OF NaI(Tl) CRYSTALS. Z. B. Baturicheva, N. Yu. Gurevich, Yu. A. Tsirlin, and V. A. Shvets. Opt. Spectry. (USSR) (English

Transl.), 17: 397-8(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 737-8(Nov. 1964).

Single crystals of NaI(Tl) with a thallium content of 0.07% were studied to determine effects of plastic deformation on their luminous efficiency during gamma excitation. The luminous efficiency decreased with increasing plastic deformation. Simultaneously, an increase in the absorption by these crystals was observed, which was practically the same for all wavelengths in the 500 to 1100 mμ range. The change of the luminous efficiency was found to be due to the loss of transparency. (M.C.G.)

15626 EFFECT OF F-BAND ILLUMINATION ON THE X-RAY LUMINESCENCE OF ALKALI-HALIDE PHOSPHORS. N. D. Maksimova. Opt. Spectry. (USSR) (English Transl.), 17: 426-7(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 790-2(Nov. 1964).

The influence of F-band optical illumination on the stationary luminescence of phosphors of KCl(Tl) and KBr(In) during x-ray excitation was investigated as a function of the temperature of excitation and of the concentration of activator in the crystal. The F-band illumination caused the intensity of luminescence of all phosphors to initially increase. Then it fell to a stationary level. It was found that the intensity of x-ray luminescence under stationary conditions of F stimulation can be larger than, smaller than, or equal to the intensity of an x-ray luminescent phosphor without F irradiation, depending on temperature or activator concentration. (M.C.G.)

15627 M-SHELL FLUORESCENCE YIELDS OF BISMUTH, LEAD, GOLD, AND OSMIUM. R. C. Jopson, Hans Mark, C. D. Swift, and M. A. Williamson (Univ. of California, Livermore). Phys. Rev., 137: A1353-7(Mar. 1, 1965). (UCRL-7937)

The partial M-shell fluorescence yields of four heavy elements (Bi, Pb, Au, and Os) were determined. The method employed was similar to that used for previous measurements of L-shell fluorescence yields. Thin foils of the materials to be studied were exposed to x rays or gamma rays which could create vacancies in the L shells of the irradiated materials. The M-shell fluorescence yields were then determined by measuring the coincidence rate between the L and the M x rays observed following the L-shell ionization. It is shown that for the method used the M-shell fluorescence yield determined is predominantly a combination of the fluorescence yields of the M_{IV} and the M_V subshells. The following values were obtained: Bi, 0.037 ± 0.007; Pb, 0.032 ± 0.006; Au, 0.030 ± 0.006; and Os, 0.016 ± 0.003. (auth)

15628 THEORY AND OBSERVATION OF SELF-TRAPPING OF RESONANCE RADIATION IN GADOLINIUM CHLORIDE. U. El-Hanany, G. Rakavy, J. J. Wagschal, and S. Yatsiv (Hebrew Univ., Jerusalem). Phys. Rev., 137: A1548-55(Mar. 1, 1965).

Self-trapping of resonance radiation in gadolinium chloride is experimentally and theoretically investigated at 77°K. The dependence of the self-reversed line shapes on crystal thickness is used to distinguish between different elementary line profiles. By comparing the observed dependence of the peak separation on crystal thickness with theory, it is shown that the lines have Lorentzian profile. This indicates that the elementary profile of the lines is determined by lifetime broadening due to relaxation processes. The mean free path and width of the lines are also obtained by this method. A direct observation of the line profile seems to be difficult in the present case. The Boltzmann equation for transport of photons in planar geometry is solved numerically for Lorentzian and Gaussian line profiles. The dependence of line shape on crystal thickness and on direction of observation is calculated. Results of calculations of the amplification of nonresonant lines accompanying the resonance emission, and the lengthening of the period of the fundamental decay mode of the resonance radiation in the crystal, are also presented. (auth)

15629 THERMOLUMINESCENCE AND PHOSPHORESCENCE IN POLYETHYLENE UNDER ULTRA-VIOLET IRRADIATION. A. Charlesby and R. H. Partridge (Royal Coll. of Science, Swindon, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 329-42(Jan. 19, 1965).

The thermoluminescence of polyethylene induced at low temperatures by ultraviolet radiation was studied and compared with that induced by γ radiation. Although considerable similarity existed between these two, the total thermoluminescence output under ultraviolet irradiation was found to be dose rate dependent, whereas under γ irradiation it was independent of dose rate. Study of the low temperature ultraviolet-induced phosphorescence of polyethylene, together with data from preceding studies, enabled a model to be suggested to explain this basic difference. This involved the double excitation and consequent ionization of carbonyl molecules attached to the molecular chains when exposed to ultraviolet radiation, while γ radiation was able to cause direct ionization. Measurement of the phosphorescence intensity variation with temperature for a typical low-density polyethylene showed very clearly the two main polyethylene structural transitions noticed in the previous thermoluminescence studies. (auth)

15630 INFLUENCE OF RADIATION ON REACTIVITY AND CATALYTIC ACTIVITY OF SOLIDS. E. H. Taylor (Oak Ridge National Lab., Tenn.). Pure and Appl. Chem., 9: No. 3, 409-22(1964). (ORNL-P-215)

Studies were made on the premise that high-energy radiation can be used to introduce defects in a partly controllable way into solids, that these defects may influence various manifestations of reactivity, and that the altered reactivity can therefore be attributed to a specific entity in the solid. The various manifestations of reactivity of irradiated solids are discussed. Adsorption, catalysis, reaction with foreign molecules, activation of adsorbed molecules, and self-reactivity are considered. (M.C.G.)

15631 SOME ELECTROCHEMICAL MEASUREMENTS IN AQUEOUS SOLUTIONS OF OXALIC ACID WITH DROPPING MERCURY AND PLATINUM ELECTRODES DURING GAMMA IRRADIATION. D. S. Ovcin, O. I. Micic, and I. G. Draganic (Inst. of Nuclear Sciences "Boris Kidric," Vinca, Yugoslavia). Radiation Res., 24: 324-36(Feb. 1965).

Electrochemical measurements were made during irradiation in 50 mM oxalic acid solutions with different pH's, with and without oxygen. The oxygen consumption was measured with the dropping mercury electrode in acid, neutral, and alkaline media, and in an acid medium with the rotating platinum electrode. The measured values were in good agreement with the previously suggested mechanism of oxalic acid radiolysis at different pH. These measurements allowed a simple determination of the total radical yield ($G_H + G_{OH}$). As can be derived from the data, it continually decreases from 6.58 to 4.48 with a pH increase from 1.6 to ~9. All the experimental results could be explained only by the participation of the molecular products of radiolysis. (auth)

15632 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF BUTADIENE TO POLYETHYLENE AND POLYPROPYLENE. Akira Furuhashi and Masao Kadonaga. Rev. Elec. Commun. Lab. (Tokyo), 12: 755-66(Nov.-Dec. 1964).

Polyethylene and polypropylene films were irradiated by ^{60}Co gamma rays in butadiene gas flow or in the liquid state. Irradiating in the butadiene gas flow was found to be particularly convenient because the gas-state monomer is available directly and little homopolymer is produced. In this case, there was a retardative effect on grafting near the surface of the film and the grafting rate showed maximum values at 50 to 60°C. When the films were irradiated in liquid butadiene, the retardative effect near the surface decreased, and the grafting rate (R_p) is represented by the equation $R_p = K[M]^{3/2}I^{1/2}$. The grafting rate was always higher in high-density films than in low-density films. From the results obtained with an x-ray diffractometer and an electron microscope, it was concluded that the grafting reaction occurs predominantly near the surface of the crystallite (lamella) of polyethylene and the grafting rate is not affected by the overall crystallinity of the trunk polymer but the configurational structure such as the degree of branching or side-chain length. (auth)

15633 RADIOLYSIS OF CYSTEINE AND COMPLEX MOLECULES WITH SH LINKAGE. I. RADIATION CHEMISTRY OF CYSTEINE IN THE PRESENCE AND ABSENCE OF IRON IN AQUEOUS SOLUTION. Niro Matsuura and Kazuko Muroshima (Tokyo Univ.). Sci. Papers Coll. Gen. Educ., Univ. Tokyo, 14: 183-95(Dec. 1964).

The effects of ferrous ions on the radiolysis of cysteine by a chain mechanism were studied. Sample solutions were saturated with air or air flashed with nitrogen and irradiated with gamma rays from a ^{60}Co source. The decrease of cysteine and yields of cystine in the solutions were determined polarographically. Data are presented in graphs. The presence of ferrous ions and oxygen greatly increased the radiolysis of cysteine in 0.8N H_2SO_4. (M.C.G.)

15634 RADIOLYSIS OF CYSTEINE AND COMPLEX MOLECULES WITH SH LINKAGE. II. RADIOLYSIS OF Co(III)-BISCYSTEINATE COMPLEX IN AQUEOUS SOLUTION. Niro Matsuura (Tokyo Univ.) and Kazuko Muroshima. Sci. Papers Coll. Gen. Educ., Univ. Tokyo), 14: 197-204(Dec. 1964).

Comparative studies were made of the radiolysis of cysteine, biscysteinate-cobalt(III) complex, and cobalt(III) ions. Data are presented in graphs. The yields of Co(III)-biscysteinate degradation were found to be closely connected with those of cysteine rather than those of Co^{3+} to Co^{3+}. The radiolysis of cysteine and Co(III)-biscysteinate was strongly dependent on the solute concentration, while that of Co(III) ions was not dependent on solute concentration at all. Mechanisms for the reactions are discussed. (M.C.G.)

15635 STUDY OF ACTIVATED LATTICE DISORDERS IN LITHIUM FLUORIDE BY NEUTRON IRRADIATION. H. Peisl, W. Kapfhammer, and W. Waidelich (Technische Hochschule, Darmstadt, Ger.). Solid State Commun., 2: 167-9(June 1964). (In German)

Changes in the lattice parameters and density of lithium fluoride were investigated after neutron irradiation. Up to a dose of 10^{17} neutrons per cm^2 Frenkel defects were predominant. For heavier irradiations defects of Schottky type were also formed. (auth)

15636 RADIOLYSIS OF BENZENE BY HEAVY IONS. Robert H. Schuler (Brookhaven National Lab., Upton, N. Y. and Mellon Inst., Pittsburgh). Trans. Faraday Soc., 61: 100-9(Jan. 1965). (RRL-138)

The differential yields for production of hydrogen from benzene by cyclotron protons, deuterons, and helium ions were examined. In the region above a few Mev these differential yields were only slightly greater than the yields observed with fast electrons. A very marked increase, particularly with helium ions, occurred as the energy was reduced toward zero. The isotopic composition of the hydrogen produced in the helium-ion irradiation of 1:1 mixtures of benzene and benzene-d_6, in spite of the dominant contribution from reactions that occurred at the end of the track, was very similar to that observed in electron irradiation. Various models, which can explain the excess hydrogen produced in the terminal region, are considered. Among these are models in which the hydrogen is produced by reaction knock-on protons and by reactions of ion-pairs formed as a result of charge exchange by the ionizing heavy particle. (auth)

15637 CORRELATIONS IN THE RADIATION POLYMERIZATION OF DIPHENYLVINYLPHOSPHINE OXIDE IN THE MELT. Yu. G. Chikishev, B. L. Tsetlin, S. R. Rafikov, Yu. M. Polikarpov, T. Ya. Medved, M. I. Kabachnik (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Vysokomolekul, Soedin., 7: 33-8(Jan. 1965). (In Russian)

The radiation polymerization of diphenylvinylphosphine oxide in the melt was investigated in relation to the dosage, dose rate, and temperature and the properties of the resultant polymers were determined. It was found that the polymerization rate at constant dose rates does not change with the dosage up to high degrees of reaction (70–80%), the radiation yield and molecular weight of the polymer being independent of the dose rate. The over-all activation energy of the process is positive and has a value of 6.3 kcal/mole over the temperature range 120–200°C. The radioinduced polymerization of diphenylvinylphosphine oxide is a special case, differing in its basic kinetic characteristics from all other radiation polymerizations, both radical and ionic, described heretofore. (auth)

15638 RADIATION OXIDATION OF POLY-ε-CAPROLACTAM. A. I. Brodskii, A. S. Fomenko, T. M. Abramova, E. P. Dareva, A. A. Galina, E. G. Furman, L. A. Kotorlenko, and A. P. Gardenina (Pisarzhevskii Inst. of Physical Chemistry, Academy of Sciences, Ukrainian SSR and Kiev Branch, All-Union Scientific Research Inst. of Synthetic Fibers, USSR). Vysokomolekul. Soedin., 7: 116-22(Jan. 1965). (In Russian)

It was found by the method of EPR and isotopic substitution that the free radicals arising in γ irradiated poly-ε-capramide possess the structure —$CH_2CONHCHCH_2$—. The presence of H_2 and CO in the gas phase both in radiolysis under vacuum and in radiative oxidation show that in both cases rupture of the C–H, C–N and C–CO bonds takes place. This is supported by the change in viscosity of the amino-end group containing polymer in the course of radiation oxidation and decrease in intensity of the methylene C–H, CO, CN, and amide NH absorption bands in the ir spectra of polymer films irradiated in an oxygen atmosphere. Increase in the carbonyl stretching band intensity of carbonyl-containing compounds in the same ir spectra and the simultaneous increase in yield of peroxide and carboxyl-containing compounds bear evidence of simultaneously occurring reactions of the RO_2 radicals in all the above compounds. The antioxidant N,N'-di-β-naphthyl-p-phenylenediamine retards the radiation oxidation of the polymer. At 30°C, the oxidation proceeds according to a nonchain mechanism that passes over to a chain mechanism on raising the temperature to 70–100°C. (auth)

15639 RADIATION CHEMICAL CROSSLINKING OF POLYETHYLENE. G. K. Kaurkova, A. A. Kachan, K. A. Kornev, and L. L. Chervyatsova. Vysokomolekul. Soedin., 7: 183(Jan. 1965). (In Russian)

The radiation chemical crosslinking of polyethylene in the presence of sulfur monochloride introduced into the polymer from the vapor phase was investigated. It was found that using 5–10% sulfur monochloride practically complete crosslinking of polyethylene is attained with doses of 0.1 MRad. The radiation chemical yield of the process is $1.25 \cdot 10^3$. It was also found that crosslinking leads to augmentation of the mechanical strength of polyolefins, particularly at elevated temperatures. Thus, for example, at 150°C the tensile strength of the modified polyethylene was 83 kg/cm^2, whereas the unmodified specimen melts at 114°C. Suggestions regarding the possible mechanism of the crosslinking of polyolefins in the presence of sulfur monochloride are made. (auth)

15640 REACTIONS OF THE REDUCING SPECIES IN THE RADIOLYSIS OF AQUEOUS METHANOL SOLUTIONS. J. H. Baxendale and R. S. Dixon (Univ. of Manchester, Eng.). Z. Physik. Chem. (Frankfort), 43: 161-76(Nov. 1964).

Hydrogen yields from γ-irradiated aqueous methanol were measured at various acidities and in the presence of various metal and complex ions. Certain cations were found to react with the reducing species only in less acid solutions where it exists as the hydrated electron, e^-_{aq}, and the effect of such ions on the radiolytic products in different conditions was observed. In particular the experiments confirmed that there is a small yield of hydrogen atoms in addition to e^-_{aq}, and indicated that for at least part of the molecular hydrogen, e^-_{aq} is the precursor. The energetics of the reactions of e^-_{aq} with these ions are discussed. (auth)

15641 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF MALEIC ACID. D. V. G. L. Narasimha Rao (Solid State Physics Lab., Delhi). p.349-53 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Single crystals of maleic acid grown by slow evaporation of water from an aqueous solution were irradiated at room

temperature with a kilocurie ^{60}Co gamma source for ~40 hrs. ESR measurements were made at 9 Bc. The radical formed was found to be very stable, and samples gave the same spectra even after a lapse of a year after irradiation with almost the same intensity. The nature of the free radical was discussed. (C.E.S.)

15642 ESR OF COLOUR CENTRES IN γ-IRRADIATED PLANAR LEAD HALIDES. A. V. Patankar and E. E. Schneider (Tata Inst. of Fundamental Research, Bombay and Univ. of Newcastle on Tyne, Eng.). p.354-61 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Single crystals of PbI_2 and $PbCl_2$ were irradiated with ^{60}Co gamma rays at liquid nitrogen temperature. Observations of the ESR spectra of the color centers, spectra after thermal bleaching, the spin-lattice and spin-spin relaxation times, growth rates of the color centers, and line shapes are discussed. Possible mechanisms of coloration are suggested. It was shown that gamma irradiation is responsible for the motion and generation of dislocations as well as the lattice ionization. (M.J.T.)

15643 IMPLICATIONS FOR RADIATION CHEMISTRY OF LARGE ELECTRON PULSES OBSERVED IN PURE HYDROCARBONS. Samuel I. Taimuty and Aryeh H. Samuel (Stanford Research Inst., Menlo Park, Calif.). 7p. (CONF-654-37)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Models of radiation effects in matter are discussed briefly, with emphasis on Samuel and Magee's charge recombination model in organic liquids. Experiments are described which were conducted to study electron mobility in pure paraffins. In these experiments, zone-refined n-octacosane in an electric field of ~1000 v/cm was irradiated with a weak ^{60}Co source, and large electron pulses were observed and attributed to electron avalanching in the hydrocarbon. Calculations were made for the mean free path λ and mobility μ required for electron multiplication; for the case of trapping and release of electrons, $\lambda = 80$ A and $\mu = 20$ cm^2/v-sec. (D.L.C.)

15644 CHEMICAL EFFECTS OF (n,γ) NUCLEAR TRANSFORMATIONS IN MIXED CRYSTALS OF THE TYPE $K_2ReBr_6-K_2SnCl_6$. H. Mueller (Universität, Freiburg i. B.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/16, 21p. (CONF-773-23)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The chemical effects of the nuclear reactions $^{185}Re(n,\gamma)^{186}Re$ and $^{190}Os(n,\gamma)^{191}Os$ were investigated for $K_2ReBr_6-K_2SnCl_6$, $K_2ReCl_6-K_2SnBr_6$, $K_2OsBr_6-K_2SnCl_6$, and $K_2ReBr_6-K_2OsCl_6$ mixed crystals to distinguish between the different retention theories. The formation of all mixed hexa(chlorobromo)-rhenates and -osmates, $ReCl_nBr_{6-n}^{2-}$ and $OsCl_nBr_{6-n}^{2-}$ ($0 \le n \le 6$), respectively, seems to prove the hot spot model; the billiard-ball model must be disregarded, as in $K_2ReBr_6-K_2OsCl_6$ mixed crystals with low rhenium content the $ReCl_6^{2-}$ yield amounts to only 5%. Primary retention by conservation of the original bonds did not exceed 10%. The reaction probability of recoil atoms with chloride and bromide in the solid was nearly the same, which was shown by comparison of the recoil products in irradiated $K_2ReBr_6-K_2SnCl_6$ and $K_2ReCl_6-K_2SnBr_6$ mixed crystals. The ligands originally co-ordinated to rhenium or osmium were enriched to 35–50% in the recoil reaction products, even in the most diluted mixed crystals; this allowed the calculation of 5 A as the radius of the reaction zone and 20 atoms as its content. The hot spot theory predicts values larger by one order of magnitude and cannot account for the individual yield of the mixed chlorobromo complexes. A new model is proposed, the disorder model, to explain the chemical effects of (n,γ) transformations in solids: the recoil atom generates around its starting point only small changes in the lattice arrangement, without producing a melt, and the final fate of the recoil atom is determined by the structure of the immediate environment it has reached after having lost its kinetic energy. In the most diluted $K_2ReBr_6-K_2SnCl_6$ mixed crystals, for example, bromine-containing complexes are produced if the recoil atom still remains near the octahedron of bromine ligands; atoms that have moved further preferentially form $^{186}ReCl_6^{2-}$. The radius of the reaction zone is also a representation of the recoil range. In annealing experiments with $K_2ReBr_6-K_2OsCl_6$ and $K_2ReBr_6-K_2ReCl_6$ mixed crystals, an increase of the yield of all seven chlorobromo-rhenates was observed. This shows that annealing is no simple recombination of the recoil atom with the ligands with which it was originally bonded. (auth)

15645 RADIOLYSIS OF HEXAFLUOROETHANE. Larry Kevan and Peter Hamlet (Univ. of Chicago). 16p. (CONF-571-31)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

The radiolysis of C_2F_6 at 3 atm pressure was examined. The products and 100-ev yields were CF_4(1.4), cyclo-C_3F_6(0.26), C_3F_8(0.18), C_4F_{10}(0.12), and C_2F_2(0.03). Good material balance was obtained; the F/C ratio in the products equaled 3.0. Experiments using radical and charge scavengers indicated that 50% of the CF_4 comes from radical reactions and 50% from ionic reactions, that C_3F_8 and C_4F_{10} are formed by radical reactions, and that C_2F_2 and cyclo-C_3F_6 are formed by ionic reactions. In Ar–C_2F_6 mixtures efficient charge transfer was observed and ionic production of C_3F_8 was seen; this showed that the electronic state produced by charge transfer affects the ion's chemical behavior. It was found that C_2F_6 is about 6 times more stable to radiation decomposition than C_2H_6. It was concluded that excited molecule decompositions are relatively unimportant in the radiolysis of perfluoroalkanes. (auth)

15646 EPR STUDY OF RADIATION-PRODUCED FREE RADICALS IN ADDITIVE-TREATED PMMA. H. A. Atwater. 15p. (CONF-641009-5)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Electron paramagnetic resonance measurements were used to compare the effectiveness of various organic additives for reducing radiation damage in polymethyl methacrylate. Gamma radiation was used, and the additives studied included p-octylphenyl salicylate, resourcinol monobenzoate, hexamethyl phosphoric triamide, benzene, xylene, and toluene. Xylene proved to be the most effective protective agent, and its para isomer was more effective than the other isomers. Evidence also indicated that the benzoyl peroxide initiator used in the polymerization, gave some radiation damage protection itself. The radiation protection mechanism is considered, and the existence of a radical-terminating reaction is suggested. (D.L.C.)

15647 SZILARD-CHALMERS RECOIL REACTIONS IN METALLOPORPHINES. [PART] I. H. E. Rosenberg and T. T. Sugihara (Clark Univ., Worcester, Mass.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/51, 33p. (CONF-773-34)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The chemical consequences of neutron capture in Co, Ni, Cu, Zn, Pd, and Pt-α,β,γ,δ-tetraphenylporphine complexes were investigated. The complexes were prepared in extremely pure form by new methods. Two types of retention values were determined: retention in the parent molecules (R_c), which was obtained by chromatographing the irradiated porphines; and retention in a mixture of parent molecules and the various complexing fragments produced from the parent molecules as a result of recoil and radiation damage. These retention values ($R_{0.1N}$, R_{8N}) were determined by extracting the irradiated and dissolved porphines with 0.1N and 8N HCl. Large retention differences were observed between the isotopes in each of the three isotope pairs investigated. The isotope retention ratios observed in the parent molecules were $^{69m}Zn/^{65}Zn$ 2.1, $^{109}Pd/^{103}Pd$ 1.4,

and $^{191}Pt/^{197}Pt$ 2.2. The differences, $R_{0,1N} - R_c$ and $R_{4N} - R_c$, reflected the general order of divalent metal chelate stability constants, i.e. Pt > Pd > Cu > Ni > Co > Zn. The Co, Ni, and Pd isotopes did not respond to isothermal annealing. The ^{65}Zn, ^{191}Pt, and ^{197}Pt isotopes responded slightly while the ^{69}Zn and ^{64}Cu exhibited a more pronounced effect. The results are discussed and interpreted on the basis of differences in the recoil energy spectrum and internal conversions effects. Parental retention is attributed in part to exchange reactions resulting from collision complex formation and in part to diffusion back to the point of origin of the recoil atom. (auth)

Radiochemistry

See also Separation Processes and Procedures.

Refer also to abstract 15879.

15648 (NP-14698) K VOPROSU OB OTNOSITEL'NYKH IZMERENIYAKH AKTIVNOSTI ISTOCHNIKOV BETA-IZLUCHENIYA. (Relative Measurements of Beta-Source Activities). A. I. Denisikov (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 4p. Dep. (mn).

Beta source activity or specific β activity of solutions were measured by a relative measurement method (method of comparing the source activity with the standard activity of the same isotopic content). Curves of the counting rate as a function of aluminum filter thickness for thin sources, including ^{60}Co and $^{90}Sr + ^{90}Y$ sources, were evaluated. (R.V.J.)

15649 (NP-14700) OTSENKA TOLSHCHINY POKRYTIYA I AKTIVNOGO SLOYA ISTOCHNIKOV BETA-IZLUCHENIYA. (Relative Measurements of Beta-Source Activities). A. I. Denisikov (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1963]. 6p. Dep. (mn)

A front window counter T-25 BFL with a 1.6 mg/cm^2 mica window was used for measuring the coating and active layer thicknesses in β sources with 1 cm^2 active area. The counting rate as a function of the thickness of an organic foil for thin ^{60}Co source and as a function of aluminum coating thickness for thin $^{90}Sr + ^{90}Y$ sources was measured. (R.V.J.)

15650 STANDARD RADIOACTIVITY MEASUREMENTS. Yu. Naoru. Genshiryoku Kogyo, 9: No. 2, 28-32(1963). (In Japanese)

For calibrating radioactivity values, a standard solution is used whose activity is expressed in Curies. An absolute method may be direct with data obtained in Curies or indirect, using a calorimeter. Principles of methods using various counters are described. By a modified method the specific activity of a 20-μC/g solution was measured directly; background effects were unimportant at this high activity. The precision of ^{60}Co measurements was ±0.5% Calorimetric determinations, in which the error is 1 μwatt, were made on ^{3}H. The decay rate differed from that of a U. S. NBS standard by only 0.1%, and the result agreed with a gas counting method. (IIC-MG)

15651 THE CALIBRATION OF THE NATIONAL BUREAU OF STANDARDS' TRITIATED-TOLUENE STANDARD OF RADIOACTIVITY. S. B. Garfinkel, W. B. Mann, R. W. Medlock, and O. Yura (National Bureau of Standards, Washington, D. C.). Intern. J. Appl. Radiation Isotopes, 16: 27-33(Jan. 1965).

The difficulties encountered, and their solution, when calibrating a radioactivity standard of tritiated toluene by comparison with the NBS tritiated-water standard by means of liquid-scintillation counting, are described. Leaks in the seals of commercial vials, giving rise to uncontrolled oxygen quenching, were eliminated by modifying the seals. White plastic caps gave higher count rates than black plastic caps. A new and highly precise method of dilution was used. The ratio of the activities of the two standards was determined with a standard error of less than 0.1%. (auth)

15652 A NEW METHOD FOR THE PREPARATION OF LABELED I^{131} OLEIC ACID-1 AND TRIOLEIN-1. L. J. Anghileri (Comision Nacionale de Energia Atomica, Buenos Aires). Intern. J. Appl. Radiation Isotopes, 16: 53(Jan. 1965).

A method, based on the isotopic exchange between radioiodide and ICl, is proposed for the preparation of ^{131}I labeled oleic acid and triolein. The proposed method also avoids much of the handling. Yields based on the radioactivity for both preparations is: ^{131}I-labeled oleic acid 60-75% and for ^{131}I-labeled triolein 70-90%. (P.C.H.)

15653 PRODUCTION AND CHEMICAL PROCESSING OF Fe^{52} FOR MEDICAL USE. Y. Yano and H. O. Anger (Univ. of California, Berkeley). Intern. J. Appl. Radiation Isotopes, 16: 153-6(Mar. 1965).

A method is described for the production and chemical separation of radioactive ^{52}Fe for clinical use. Iron-52 in the form of ferrous citrate is being used to determine the distribution of erythropoietic bone marrow in both animal and human subjects with the positron scintillation camera. Detailed descriptions of the target preparation, cyclotron irradiation, and chemical processing of the ^{52}Fe are given. (auth)

15654 ABSOLUTE STANDARDIZATION WITH A NaI(Tl) CRYSTAL. V. CALIBRATION OF ISOTOPES WITH COMPLEX DECAY SCHEMES. G. A. Brinkman and A. H. W. Aten, Jr. (Inst. for Nuclear Physics Research, Amsterdam). Intern. J. Appl. Radiation Isotopes, 16: 177-81(Mar. 1965).

Previously a method was described to calibrate radioisotopes, which emit two or more γ rays in coincidence, using the expression: $N = A_1A_2/A_{12} + T$. A_1 and A_2 are the areas under the photopeaks of γ_1 and γ_2; A_{12} is the area under the sumpeak and T the area under the whole spectrum. Some equations are now given for isotopes with very complex decay schemes. It is proved that the simple equation given above is valid if one of the γ rays occurs for 100% and if there is no angular correlation. (auth)

15655 THE PREPARATION AND PROPERTIES OF CARRIER-FREE LEAD-212 AMALGAMS. H. L. Hamester and M. Kahn (Univ. of New Mexico, Albuquerque). Intern. J. Appl. Radiation Isotopes, 16: 211(Mar. 1965). (SC-DC-3573)

Using carrier-free ^{212}Pb, it was found that lead amalgams as dilute as 10^{-12} are unstable with respect to oxygen. Attempts were made to prepare the amalgams via electrodeposition of ^{212}Pb from aqueous solutions and collection of the active deposit of ^{220}Rn in vacuo and also by collection of the active deposit on mercury in vacuo (~5×10^{-6} mm Hg). It was estimated that under the conditions used, oxygen at a pressure of only 10^{-11} mm Hg would have been sufficient to react completely with all of the ^{212}Pb associated with the mercury. (P.C.H.)

15656 CORRECTIONS IN X-γ COINCIDENCE CALIBRATIONS OF E.C. RADIONUCLIDES. H. Houtermans and M. Petel (International Atomic Energy Agency, Vienna). Intern. J. Appl. Radiation Isotopes, 16: 215-16 (Mar. 1965).

Equations are given for corrections in x-γ coincidence calibrations of electron capture radioisotopes. The equations are appropriate for conditions in which an x-ray pulse and a γ-pulse are registered simultaneously by the x-ray detector. It is mentioned that for all coincidence calibrations, where an appreciable fraction of the counts in the x-ray (or β-ray) counter is due to the γ rays, the discrimination in the γ channel should be set just below the photopeak, in order to avoid γ-γ coincidences by scattering. Some details of a calibration of ^{54}Mn are given to give an idea of the magnitude of the corrections. (P.C.H.)

15657 SYNTHESIS OF ARSANILIC-As^{74} ACID AND ARSANILIC-1-C^{14} ACID. R. L. Fredrickson, S. F. Bocchieri, H. J. Glenn, and L. R. Overby (Abbott Labs., North Chicago, Ill.). J. Assoc. Offic. Agr. Chemists, 48: 10-17 (Feb. 1965).

Arsanilic-^{74}As acid and arsanilic-1-^{14}C acid (p-aminophenyl arsonic acid) were synthesized in 20–30% yield with

high radiopurity by way of the Bart reaction. Appropriately labeled p-nitrophenyl diazonium borofluoride and sodium arsenite were coupled, and the resulting labeled p-nitrophenyl arsonic acid was reduced to arsanilic acid by treatment with iron and hydrochloric acid. Purification procedures are described. (auth)

15658 A METHOD FOR REACTING SUBMICROGRAM QUANTITIES OF RADIOACTIVE SUBSTANCES. OBSERVATIONS ON THE PREPARATION OF ^{131}I-IODOTYROSINES OF VERY HIGH SPECIFIC ACTIVITIES. W. S. Reith and B. L. Brown (Inst. of Nuclear Medicine, London). Nature, 205: 513(Jan. 30, 1965).

Differences in the specific activities of ^{131}I-iodotyrosines obtained in a number of iodinations though the experimental conditions were kept as nearly identical as possible are discussed. Changes in the method and types of equipment used are described. (P.C.H.)

15659 ON THE INCORPORATION OF 5,7,4′-TRIHYDROXYFLAVANONE- 2,6,8,10-$^{14}C_4$ IN CYANIDIN AND THE ISOFLAVONES BIOCHANIN A AND FORMONONETIN. Leni Patschke, Wolfgang Barz, and Hans Grisebach (Universitat, Freiburg i.B.). Z. Naturforsch., 19b: 1110-13(Dec. 1964). (In German)

Phloroglucinol-[2,4,6-$^{14}C_3$] was synthesized from ethyl malonate-[2-^{14}C] and condensed with p-carbethoxycoumaryl chloride; the resulting product was saponified to form 5,7,4′-trihydroxyflavanone-[6,8,10-$^{14}C_3$] (II). The latter compound was mixed with 5,7,4′-trihydroxyflavanone-[2-^{14}C] to yield the desired 5,7,4′-trihydroxyflavanone-[2,6,8,10-$^{14}C_4$] (III). Administration of a sample of III in which the activity ratio ring A/C-2 was 1:2.04 to red cabbage seedlings led to a cyanidin with an activity ratio ring A/C-2 1:2, as was shown by degradation of the cyanidin to phloroglucinol and protocatechuic acid. This result proves that III is incorporated intact into cyanidin. After administration of III to chana germ (Cicer arietinum) Biochanin A (5,7-dihydroxy-4′-methoxyisoflavone) with an activity ratio of 1:2.24 was obtained. In contrast, there was only a small amount of incorporation of III into formononetin (7-hydroxy-4′-methoxyisoflavone), and the activity ratio fell to 1:7. These results prove the intact and specific incorporation of III into Biochanin A. When II is fed to Cicer arietinum about 3% of the total activity is found in the respiratory carbon dioxide after 48 hours. From this observation it was concluded that the plant is able to degrade ring A of II. (auth)

15660 ON THE FORMATION OF 4,2′,4′,6′-TETRAHYDROXYCHALCONE-2-GLUCOSIDE AND 4,2′,4′-TRIHYDROXYCHALCONE-4′-GLUCOSIDE IN RED CABBAGE SEEDLINGS AND PETUNIAS. Leni Patschke, Dieter Hess, and Hans Grisebach (Universitat, Freiburg i.B. and Max-Planck-Institut fur Zuchtungsforschung, Cologne). Z. Naturforsch., 19b: 1114-17(Dec. 1964). (In German)

Both 2′,4,4′,6′-tetrahydroxychalcone-2′-glucoside-[β-^{14}C] (I) and 2′,4,4′-trihydroxychalcone-4′-glucoside-[β-^{14}C] (II) were converted into cyanidin-[2-^{14}C] in red cabbage seedlings, even though chalcone II does not possess the phloroglucinol-type pattern of substitution in ring A. Therefore the possibility that the incorporation of the chalcones proceeds via a degradation to p-coumaric acid was considered. After administration of II to red cabbage seedlings p-coumaric acid-[β-^{14}C] could be isolated by means of dilution analysis, the location of the radioactivity being proved by degradation of the p-coumaric acid. After administration of I to Petunia hybrida radioactive p-coumaric acid and ferulic acid were isolated from the shoots and blossoms. It was deduced from these results that the plants are able to split chalcones I and II — or the corresponding flavanones — between the carbonyl group and ring A. (auth)

Separation Processes and Procedures

See also Analytical Procedures.

15661 (AFCRL-64-1018) THE ION EXCHANGE PROPERTIES OF CERIUM(IV) COMPOUNDS. Physical Sciences Research Papers No. 73. G. G. Rocco (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass. and Tracerlab, Waltham, Mass.), J. R. Weiner, and J. P. Cali (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Dec. 1964. Contract AF19(628)-3844. 44p.

The ion exchange properties of ceric phosphate were investigated including rates of reaction, distribution coefficients of alkali metals, capacity, and column behavior of some elements. Ceric oxide was shown to possess anion exchange properties in acid solution and cation exchange properties in basic solution. The two compounds have properties analogous to, but not identical with, zirconium oxide and phosphate. Cesium and barium were successfully separated on a short column of ceric phosphate at room temperature. These inorganic ion-exchangers show promise of providing additional means for effecting and widening the scope of radiochemical separations, an important and necessary consideration in the radioactivation analysis, of trace elements in ultrapure materials. (auth)

15662 (ANL-6900(p.45-142)) CHEMICAL-METALLURGICAL PROCESSING. (Argonne National Lab., Ill.).

The first core loading of the EBR-II reactor will be processed for recycle to the reactor by the melt refining process. Study was continued of a halide slagging process, a melt-refining-type process, in which rare earth fission products present in discharged U or U-Pu fuel alloys are preferentially oxidized and extracted from the molten fuel alloy into a molten, overlying halide salt phase. The Ce-Pu separation factor averaged 7300 in two runs. The Pu extraction varied directly with the amount of oxidant employed. For the small scale of these experiments (700 g of metal alloy), product yields (as poured ingot) were high (97% or greater). Materials are being investigated for containing U and its alloys at temperatures from their melting point to several hundred degrees above their melting point. Of the materials tested to date for containing molten U at 1400°C (TiB_2, CrB_2, ZrB_2, and TiC), only ZrB_2 was unattacked in a relatively short test (8 hr). The purification of Ar from N_2 is frequently desired and may be required for future processing operations in the Ar-atmosphere cell of the EBR-II Fuel Cycle Facility. Presently under study is a method whereby the N_2 is gettered on hot Ti sponge. During the past report period, a 10-cfm pilot plant, designed to provide information on component design and reliability for large-volume purification systems, was operated for 1000 hr and then shut down for inspection and recharging of the Ti bed. Operation was trouble-free, and all components and instrumentation performed their design functions well. Work was continued on the development of the skull reclamation process for recovery of melt refining crucible residues (known as "skull" material). A part of the skull reclamation process is conducted in molten Zn-Mg systems and molten halide salt media. This portion of the process, which involves six process steps, is presently being demonstrated in a pilot plant which has a capacity of about 2 kg of skull oxide per process batch (which compares with a plant batch size of 7 kg of skull oxide). Major remaining problems are the evaluation of various containment materials, the control of salt fumes, and the elimination of residual waste salt from a U product solution prior to retorting this solution for isolation of U metal. In the EBR-II skull reclamation process, a flux consisting of 47.5 mole % $CaCl_2$, 47.5 mole % $MgCl_2$, and 5.0 MgF_2 was used in the reduction of uranium oxides by Zn-Mg solution. Determinations of the solubility of MgF_2 in $CaCl_2$-$MgCl_2$ mixtures showed that the temperature coefficient of MgF_2 solubility is negligible. It was also found that the MgF_2 in this flux is at or very near its solubility limit. Because MgF_2 is hydrated, CaF_2, which may easily be obtained without water of hydration, is being substituted for MgF_2. Development work has continued on pyrometallurgical methods for reprocessing fast breeder reactor fuels. The primary effort is devoted to metallic fuels. Since mechanical removal of cladding from highly irradiated metallic fuels may not be feasible, chemical decladding methods are being investigated. In the case of V-Ti alloy, a promising

cladding material, scouting studies indicate that chlorination procedures may prove useful. The resulting chlorides of V and Ti appear to be easily separated from the fuel by volatilization. Studies were conducted on the use of Cd-Mg-Zn alloys as process solvents. The Cd-rich region of this system, because of reduced operating temperatures and low Zn concentrations, might permit the use of stainless steels instead of Ta or W process vessels. Measurements of the solubility of U over the entire composition range of this solvent were completed. Two regions of maximum U solubility are evident in the ternary diagram, one at about 52 at % Zn and 48 at % Mg, and the other at about 83 at % Cd and 17 at % Zn. At 600°C, the solubilities of U at these two points are approximately 0.75 at % and 3.5 at %, respectively. Pu solubility measurements were also made in solvent composition regions where the solubility of U is sufficiently high for process purposes. In general, the solubility of Pu in these regions is three to six times greater than that of U. Since fast breeder reactor fuels contain a much higher proportion of U than Pu, the solubility of U will dictate the choice of solvent composition. Pu showed only a small tendency to coprecipitate with U from a solvent consisting of 69 at % Cd, 16 at % Zn, and 15 at % Mg. Doerner-Hoskins coefficients were 0.068 and 0.164, compared with a value of 0.66 in 100% Zn solution. Further distribution coefficients for Pr were determined, using Cd-Mg-Zn alloy as the metal phase and 30 mole % NaCl-20 mole % KCl-50 mole % $MgCl_2$ as the salt phase. By varying the composition of the metal phase, the distribution coefficient of Pr (a representative rare earth fission product) can be adjusted to different values. Using information now available on U and Pu solubilities, corrosion rates of stainless steel, distribution coefficients of pertinent elements, and melting point data, it has been possible to select composition regions in the Cd-Mg-Zn system that are suitable for use in various process flowsheets. Brief studies of the distribution behavior of Es and Cf between liquid Zn-Mg alloys and molten $MgCl_2$ showed that both of these elements tend to seek the salt phase. With increasing Mg concentration above about 30 at %, the distribution coefficient of Es increases while that of Cf decreases, suggesting the possibility of additional transuranium element separations by this method. The ternary systems, LiCl-NaCl-$MgCl_2$ and LiCl-KCl-$MgCl_2$, offer promise as effective salts for the extraction of rare earth fission products from liquid metal solutions of U and Pu. Liquidus temperatures of the system LiCl-NaCl-$MgCl_2$ were determined over the entire composition range. In order to obtain satisfactory distribution coefficients for the required separations, it is desirable for the salt to contain at least 50 mole % $MgCl_2$, and for the remainder to be as rich in LiCl as possible. A liquid region was found to exist below 550°C with a minimum of 50 mole % $MgCl_2$ and LiCl concentrations up to about 30 mole %. Thus a satisfactory region appears to be available for the desired operating temperature of 600°C. Work was started on a program to develop engineering technology required for the separation of Pu and U from rare earth fission products by multistage extractions between molten metal and molten salt systems. Work is now pointed toward the development of a packed extraction column and associated equipment for contacting molten metal and salt phases. In a study of the nonturbulent vaporization of Hg(vaporization from the free liquid surface without bubble formation), the existance of a steep temperature gradient (115°C/in.) in a thin (~0.2-in. thick) surface layer, which had been previously shown, was confirmed by additional measurements made during the past report period. It was postulated that the primary mechanism of heat transfer is one of convection whereby superheated eddies from the pool penetrate to the surface and lose a portion of their sensible heat (superheat) in vaporization. Work was continued on a program to determine the critical constants of alkali metals. Equipment for this program was constructed and is now being put into good operating condition. The catalyst in the Ar purification system became poisoned by Hg which accidentally spilled into the Argon Cell from an overhead seal. The poisoned catalyst was replaced with fresh catalyst and the Argon Cell was refilled with Ar, following which the O_2 and water concentrations in the Ar were reduced to 10 and 60 ppm, respectively. Operation of the transfer locks by means of motorized drives had caused extensive wear of the drive gears. These gears were replaced with hardened gears and the drives were modified to increase their reliability. The manipulators were modified to increase their reliability. New shafts were installed in the bridge drives. The shielding windows of the Argon Cell were modified by adding a ¼-in.-thick glass cover plate on the inner cell-side of each window. The cover plates will prevent bruising impacts on the thick window panes and resultant disruptive discharges of gamma-induced electrical charges in the shielding windows. Nineteen runs with unirradiated, U-fissium alloy were carried out by remote means in the melt refining furnaces in the Argon Cell. The purpose of the runs was to prepare ingots suitable for use in the injection casting furnace. The poured yields varied from 83 to 97 wt %, twelve of the yield being greater than 94 wt %. Concentric shielding plugs are provided in the floor of the Air Cell to permit the transfer of materials. These plugs were modified to provide shielding between the bottom of the cell floor and a shielded coffin during the transfer of irradiated fuel subassemblies. The fuel transfer coffin was used for the in-situ removal of Na from four mock-subassemblies which had been in the Na-filled reactor vessel. The amount of Na remaining on the subassembly fuel pins after processing was estimated to be 3 g. A disposal container for burying solid radioactive wastes from the Fuel Cycle Facility was tested. The tests showed that the container is adequate for the proposed usage. An Ar atmosphere enclosure system is being installed to investigate the effect of a dry Ar environment on the operation of equipment items which will be used in the Argon Cell. A skull oxidation furnace, furnace control system, and a skull oxide dumper were successfully tested in six runs (with unirradiated U-fissium alloy) and were installed in the Fuel Cycle Facility. The skull reclamation process involves a number of heating and cooling operations. Self-heating (4 to 5 kw) of fission products imposes a special problem in cooling operations. Tests were made in a simulated process furnace to determine the effect of this self-heating on the cooling rate of the furnace. The results of the tests showed that in the furnace design special considerations must be given to means for facilitating cooling. A furnace, enclosed in a water-cooled bell jar, was used to investigate the distillation and U consolidation steps of the skull reclamation process. Experiments in which the furnace was operated in air resulted in poor U yields. The furnace is being installed in a glovebox containing a dry Ar atmosphere. The solubility of Kr in Na was measured. The theoretical implications are briefly discussed. Experiments on the analysis of Na for O_2 by the fast neutron method are proceeding. The dry oxidation method for analysis of Na for C is now giving good recoveries with low blanks. The apparatus for the determination of thermodynamic functions of alkali metals and their alloys by optical resonance absorption spectrophotometry is now functioning satisfactorily. Thermodynamic properties of the La–Cd system were obtained by both the emf cell and the effusion pressure methods. At 400°C the free energies of formation of the intermetallic compounds, as determined by the latter method are (in kcal/gram atom La): $LaCd_{11}$, -45.7; La_2Cd_{17}, -42.3; La_3Cd_{13}, -35.5; $LaCd_2$, -24.1; LaCd, -14.9. For $LaCd_{11}$ the corresponding value determined by the emf cell method is -43.0. Refractory compounds of the actinide elements show promise as reactor fuels capable of withstanding high temperatures and large burnups. The liquid-metal precipitation process for the preparation of UC produced a product with good pressing and sintering properties. Twelve UC production runs using the liquid-metal precipitation process were completed on a 500 to 1000 g scale of U metal. The O_2 content of the UC product was reduced (~0.2 wt %) to the point where the primary source of O_2 contamination is the O_2 content of the C used in the process. The C contents of the UC products varied from ~5.2 to 6.0 wt % (theoretical C content for UC = 4.8 wt %); however, recent changes in

process variables (longer reaction times and lower C/U ratio of reactants) show promise of producing a UC product with < 5.2 wt % C. A fluid-bed method for the preparation of UC from powdered U metal and a hydrocarbon gas is being studied. The work to date is primarily limited to the design and construction of laboratory equipment. Additional work was done on the use of Mg_2C_3 for the preparation of metal carbides. A new experimental program was initiated to study slurries and pastes consisting of fertile, solid compounds suspended in liquid metals for use as blanket materials in fast breeder reactors. The work to date was limited to the evaluation of the economic potential of slurry and paste blankets and the selection of systems for the initial experimental work. (J.R.D.)

15663 (ANL-6900(p.143-202)) FUEL CYCLE APPLICATIONS OF VOLATILITY AND FLUIDIZATION TECHNIQUES. (Argonne National Lab., Ill.).

Fluid-bed fluoride volatility processes are being developed for the recovery of U and Pu from spent nuclear fuels. Laboratory support work for these processes is continuing with a study of the fluid-bed fluorination of mixtures of U_3O_8, PuO_2, and fission product element oxides, simulating the concentrations present in a spent fuel element. The U_3O_8 and PuO_2 in the mixture represent the product that would be formed by the oxidation of UO_2-PuO_2 fuel pellets. The U_3O_8-PuO_2 mixture, mixed with alumina, is conveyed to the reactor in the fluidizing N_2 stream and is contacted with a dilute F_2 stream at a point just above that at which the U_3O_8-PuO_2 powder enters. Several experiments were performed in which an alumina bed was used for the fluorination of several additions of U_3O_8-PuO_2-fission product mixture. In the first experiment, six additions of 300 g of a U_3O_8-PuO_2-F.P. mixture containing about 0.4 wt % Pu were made to a single alumina bed. The feeding-fluorination periods were carried out at 500°C with 20 vol % Fr as the fluorinating agent. This was followed by two recycle-fluorination periods with 100% F_2: a 10-hr period at 500°C and a 10-hr period at 550°C. The Pu content of the alumina bed was 0.10 wt % after the first addition, rose to 0.42 wt % after the fourth addition, and then decreased to 0.23 wt % after the sixth addition. After the recycle-fluorination period at 500°C, the Pu concentration on the alumina was 0.19 wt %; after the recycle-fluorination period at 550°C, the Pu concentration on the alumina was 0.18 wt %. In the second experiment, two additions were made to a single alumina bed. The feeding-fluorination periods were carried out at 450°C with 20 vol.% F_2. This was followed by recycle-fluorination periods of 5 hr at 450°C, 4 hr at 500°C, and 10 hr at 550°C, all with 100% F_2. After the first feeding-fluorination period, the alumina bed contained 0.13 wt % Pu and after the second feeding-fluorination period the alumina bed contained 0.19 wt % Pu. After the three recycle-fluorination periods, the alumina bed contained 0.13 wt % Pu. In a third experiment only PuO_2 (1.5 g) and fission products (2.6 g) were fed to the reactor. Four additions were made to a single alumina bed, using a feeding-fluorination period at 500°C (20 vol % F_2) and a recycle-fluorination period of 10 hr at 550°C (100% F_2) for each of the four additions. After each recycle-fluorination period, samples were withdrawn from the bed for Pu analysis. The Pu concentration on the alumina was 0.005 wt % after the first addition, 0.014 wt % after the second, 0.015 wt % after the third, and 0.024 wt % after the fourth addition. These results show that a significant fraction of the Pu remains in the alumina and that further fluorination would be required to reduce the Pu losses to acceptable values. Feed materials evaluated included one that was prepared by oxidizing a solid solution of UO_2-PuO_2 to a mixture of U_3O_8 and PuO_2, and another prepared by physically mixing U_3O_8 and PuO_2. In the tests, the two types of feed materials did not show a significant difference in Pu retention on the alumina. In a series of experiments, PuO_2 alone or PuO_2-fission product mixtures were fluorinated. These experiments were performed to determine the variation in the Pu content of the alumina bed with quantity of Pu feed to the reactor and with quantity of fission products present. In these experiments, 1.5 or 10.5 g of PuO_2 alone or mixed with 2.6 or 19.4 g of a fission product mixture was fed into the reactor in 170 g of alumina. These concentrations of PuO_2 and fission products correspond to those in U_3O_8-PuO_2-F.P. mixtures containing 0.4 or 3 wt % Pu, respectively. The feeding-fluorination period was carried out at 500°C using 20 vol % F_2 followed by a recycle-fluorination period for 10 hr at 550°C using 100% F_2. The results showed a 20- to 30-fold increase in Pu retention on the alumina for a 7.5-fold increase in Pu fed to the reactor. The Pu retention in the absence of fission products was 0.009 wt % for the small (1.5 g) addition of PuO_2 and 0.12 wt % for the large (10.5 g) addition. The Pu retention on the alumina in the presence of fission products was 0.005 wt % for the 1.2-g addition of PuO_2 and 0.190 wt % for the large addition. Increasing the fission product level 7.5-fold resulted in an increase in Pu retention on the alumina by a factor of between three and four; 0.005 to 0.014 wt % for experiments with low Pu concentrations, and 0.19 to 0.71 wt % for experiments with high Pu concentrations. Blank experiments in which alumina alone was fed into the reactor indicated that an average value of 0.003 wt % Pu on the alumina could be considered as the background level in this reaction system. Autoradiographic experiments performed to determine the location of the Pu showed, by the alpha tracks produced in the autoradiographic emulsion, that the Pu was located exclusively on the surface of the alumina particles. Studies of the decomposition of gaseous PuF_6 to F_2 and PuF_4 by alpha radiation were continued. The average rate of decomposition of PuF_6 at an initial pressure of 100 mm Hg in 125-cc Ni spheres at 26°C decreased nonlinearly with time. In 5.6-day experiments, the average rate was 0.38% per day; in 571-day experiments, the average rate was 0.091% per day. Results of long-duration tests (571 days) indicated that the decomposition rate of PuF_6 increases when the initial pressure of PuF_6 is increased. The decomposition rate of PuF_6 at 80 to 83°C (0.65% PuF_6 per day) is higher than the decomposition rate at 26°C (0.19% per day). When PuF_4 is initially present (from a previous experiment), a lower decomposition rate (0.53% per day) is obtained at 80 to 83°C. An increase in volume of the container, that is, a decrease in the surface-to-volume ratio, caused the PuF_6 decomposition rate to decrease. In 75-day experiments, the decomposition rate decreased from 0.19% PuF_6 per day to 0.11% per day when the container volume was increased by a factor of about 50. When the surface-to-volume ratio was increased tenfold (by packing 127-cc Ni spheres with Ni wool), the average rate of PuF_6 decomposition increased from 0.19% per day to 0.30% per day. However, when the packed spheres were re-used (i.e., when PuF_4 was initially present), the average decomposition rates of PuF_6 in two experiments were 0.13 and 0.18% per day. Lattice constants for UF_6, NpF_6 and PuF_6 were calculated from available powder pattern data, using a computer program. The unit cell volumes calculated for UF_6, NpF_6 and PuF_6 were 466.0, 463.8 and 461.4 Å, respectively. The volumes of the unit cells thus decrease in the series UF_6, NpF_6 and PuF_6, showing the effect of the actinide contraction. An engineering-scale facility is being installed to permit the study of the main steps in the fluid-bed fluoride volatility processing scheme for the recovery of Pu and U from spent UO_2 fuels. The experimental work will be conducted with nonirradiated UO_2-PuO_2 sintered pellets containing fission product oxides. Studies on the hydrolysis and filtration of airborne PuF_6 were continued. The experimental program is directed toward establishing the behavior of PuF_6 in releases of dilute PuF_6 gas streams into cell or glovebox atmospheres. Experiments were conducted with diluted UF_6 in a system consisting of a packed bed of glass spheres backed up by AEC-type filter segments. Very low concentrations of UF_6 (less than 0.03 mm Hg) in N_2 were used; ambient conditions of humidity and temperature were simulated. The hydrolysis of UF_6 was found to be catalyzed by any solid surface contacted by the gas stream. The construction of new experimental facilities for measuring hydrolysis rates of PuF_6 gas is nearing completion. An investigation of a method of decladding stainless steel-clad

fuel by corrosion with aqueous Hcl in an air-fluidized bed of inert solids has begun. In tests in which no fluidizing material was present in the column, the corrosion rates were 0.5 and 1.0 mils/hr at 25 and 60°C. This suggests that the fluidized bed increases the rate of corrosive penetration, perhaps by abrasive action which removes a film of corrosion products. In subsequent tests conducted in a 1½-in.-dia. glass column a rod (½-in.-dia.) of Type 304 stainless steel was used as a corrosion specimen. The test results indicated that the rate of attack on the stainless steel increases with acid content in the bed. In experiments conducted in the glass column, severe channeling of the bed was observed and particles of the bed adhered to the wall in those tests in which the liquid content of the bed ranged from 3 to 20 wt %. It is believed that the poor fluidization at high liquid fractions may be reduced by decreasing wall effects with use of a larger diameter column. Studies on the preparation of high-density particles of UO_2 directly from UF_6 were completed. Results of these studies will be applied to mixed UF_6-PuF_6 systems as part of the fluid-bed volatility reprocessing studies on low-enriched uranium oxide fuels. The process involves reaction of the hexafluoride with a mixture of steam and H_2 in a bed of the product oxide maintained at temperatures of 650°C or above. Current work, conducted in the 3-in.-dia. Monel column that was used throughout this program, was concerned with the development and demonstration of an oxidative-fracturing method for the preparation of uranium oxide seed material. In exploratory tests, two concentrations of air were used, 10% and 20% (in N_2), at fluid-bed temperatures of 400°C and 650°C to oxidize the UO_2 and effect particle breakup. Reduction of the material back to the dioxide was achieved in periods of 30 to 60 min with H_2 at 650°C. Better results [mainly the formation of lesser amounts of fines (−325 mesh)] were achieved when the lower temperature and the higher air concentration were used. Satisfactory use of seed material prepared by the oxidation-reduction method was made in UF_6-to-UO_2 conversion runs of 12- and 17-hr duration. The seed material was fed as a side stream at given intervals. An average of 2.7 bed equivalents of UO_2 were produced. A basic investigation was started of the fluidization of fine powders in the particle size range of less than about 50 μ. The objective of this work is to quantitatively describe the effect of interparticle forces on the fluidizability and quality of fluidization. In the current experiments the following particulate materials were used: Fe with an average particle diameter, $\bar{d}_p$, of 3.3 and 1.6 μ, alumina with a $\bar{d}_p$ of 11 and 27 μ, and Ni with a $\bar{d}_p$ of 18 and 137 μ. The interparticle adhesive force and the interparticle friction coefficient were determined by the inclined-plane method. Fluidization experiments were performed in 8.2-cm ID and 14-cm ID Lucite columns. The ratio of a calculated minimum fluidization velocity to the velocity observed at incipient fluidization is being used as an index describing the fluidizability of a particulate material. The results show the index of fluidizability depends mainly on the adhesive force; the effect of the interparticle friction appears to be insignificant. Development studies on the hydrochlorination and fluorination steps of a fluid-bed volatility process for the recovery of enriched U from U-alloy fuels were continued in a 1½-in.-dia. fluid-bed reactor (Ni-200) system. Experiments were performed with normal U-Al and normal U-Zircaloy alloy plate assemblies. The process cycle included hydrochlorination, hydrofluorination, and fluorination steps. An improved fluorination procedure which requires very low F_2 rates and which may obviate the need for a F_2 recycle pump was investigated. The improved procedure involved carrying out the reaction for ½ hr at 250°C with 5 vol % F_2 while the reactor bed was fluidized to remove the bulk of the U, and completing the fluorination reaction under static bed conditions at 500°C with 90 vol % F_2 at low flow rate. Full-scale operations have started in the pilot plant facility installed to demonstrate the fluid-bed volatility process for enriched U alloy fuels. In the initial experiments, multiplate Al assemblies (no U present) weighing 12.3 and 12.1 kg and a Zircaloy assembly weighing 19.15 kg were successfully processed (hydrochlorinated) in periods ranging from 6.5 to 8.6 hr. Fluid-bed temperatures during hydrochlorination were maintained at about 370 and 290°C for the two Al runs. A temperature of 370°C was used for the Zircaloy experiment. Average hydrochlorination rates ranged from 2 to 3 kg/hr for a typical Zircaloy charge and 1 to 2 kg/hr for an Al charge. Overall HCl utilization was about 50 to 60% for both fuels. The initial experiments included a 1- to 2-hr hydrofluorination at about 300°C. The first demonstration run with a U-containing fuel assembly was also completed in the pilot plant. A 19.6-kg U-Zircaloy assembly containing about 182 g of U was processed through the hydrochlorination-hydrofluorination-fluorination cycle. The hydrochlorination and hydrofluorination conditions were similar to those employed during the shakedown experiments. The element was completely hydrochlorinated in a period of 10.9 hr. U was removed from the alumina beds by fluorination for 2 hr with 6 vol % F_2 in N_2 while the temperature is increased from 250 to 500°C, followed by a final 2-hr period at 500°C with a high F_2 concentration (~80 vol %) and with the reactor bed in a settled (nonfluidized state). The residual uranium concentration in the alumina beds, both for the reactor bed and the packed-bed filter, was less than 0.01 wt %. The fluid-bed pyrohydrolyzer for converting the waste metal chlorides to oxides operated satisfactorily in series with the main fluid-bed reactor for all experiments. Modifications to this unit included a new cone-shaped bottom section and an overflow system for continuous waste product removal. These changes appear to have contributed to the smooth operation of this unit. A corrosion program in support of the fluid-bed volatility program is in progress. Two types of tests are being conducted, laboratory-scale tests in tube furnaces and in-plant tests. A test series was completed in which Ni-200 plate and welded Ni-200 plate specimens were exposed for periods of 240, 480, and 960 hr to selected gaseous environments. The gaseous reactants were F_2, HCl-F_2, and F_2-O_2. The rates of corrosion for the unwelded plate specimens were between 0.9 and 4.1 mils/yr. The corrosion rates for specimens of Ni-200 plate welded with Ni-200 filler metal were between 0.6 and 5.0 mils/yr whereas the corrosion rates for specimens of Ni-200 welded with Ni-61 filler metal were 70 and 1315 mils/yr. (J.R.D.)

15664 (BM-RI-6601) EXTRACTION AND SEPARATION OF RARE-EARTH ELEMENTS AND YTTRIUM WITH DODECYL PHOSPHORIC ACID-KEROSINE SOLVENT. J. G. Eisele and D. J. Bauer (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Feb. 1964. 19p. Free(Bureau of Mines).

Solvent-extraction characteristics of dodecyl phosphoric acid (DDPA) were investigated to determine its potential as a fractional or selective extractant for individual elements in a rare-earth–yttrium mixture. The DDPA is an effective extractant for splitting rare-earth mixtures into light and heavy subgroups. Yttrium normally extracts with the heavy rare-earth elements but may be shifted toward an extraction sequence with the light rare-earth elements by increasing the pH. Elements in the light and heavy ends of the rare-earth series can be separated from middle-group rare-earth elements by using diethylenetriamine-pentaacetic acid (DTPA) as an aqueous phase counter-extractant. Hydrogen-ion dependency of the distribution coefficients differs from that reported for similar systems at tracer-level concentration. (auth)

15665 (CEA-R-2607) L'EXTRACTION DU NEPTUNIUM PAR LE TRILAURYLAMINE. (Neptunium Extraction by Trilaurylamine). Jacques Champion and Andre Chesne (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Études Nucléaires). Oct. 1964. 48p. Dep.(mn).

The extraction by trilaurylamine of neptunium(IV) from nitric acid and sulfuric acid–nitric acid media has been studied, with the aim of developing a purification process for this element. Relative to the plutonium–neptunium separation, conditions are given for the oxidation of nep-

tunium(IV) in sulfuric acid–nitric acid medium, and data are presented on the stabilization of the (+4) oxidation state by the organic solvent. Two procedures have been developed for the simultaneous purification of the two actinides. Both are based on the trilaurylamine extraction of the tetravalent nitrate species. The first utilizes a constant redox potential fixed by Fe^{+++}/Fe^{++} couple, while in the second, valences are determined by successive addition of nitrite and ferrous ions. Gram quantities of neptunium-237 have been recovered from plutonium process solution. Alternate procedures are suggested for the chemical processing of irradiated ^{237}Np. (auth)

15666 (Dp-714) EFFECT OF BARBITURIC ACID AND HYDRAZINE ON SOLVENT EXTRACTION AND ION EXCHANGE BEHAVIOR OF NITROSYLRUTHENIUM. Richard M. Wallace (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). July 1962. Contract AT(07-2)-1. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Extraction of nitrosylruthenium from aqueous solutions of nitric acid and inorganic nitrates into 30% tributyl phosphate was suppressed by heating the aqueous solutions with hydrazine or barbituric acid prior to solvent extraction. The treatment with hydrazine reduced the amount of ruthenium extracted by a factor of 25 and that with barbituric acid by a factor greater than 1000, under the most favorable conditions. The product of the reaction between nitrosylruthenium and barbituric acid reacts with nitrous acid to produce three species, two of which are slightly extractable into 30% TBP. The reaction between nitrosylruthenium and barbituric acid produces compounds that are not absorbed by cation exchange resins but are absorbed by anion exchange resins. (auth)

15667 (DP-752) PERFORMANCE OF A 10-INCH CENTRIFUGAL CONTACTOR. A. Thomas Clark, Jr. (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Sept. 1962. Contract AT(07-2)-1. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A centrifugal contactor, ten inches in diameter, which uses air pressure on an aqueous weir to control the position of dispersions settling in a centrifugal field, was developed. The unit will process natural or enriched uranium solutions by solvent extraction, with excellent mass transfer efficiency at total flows of at least 40 gpm. (auth)

15668 (HW-83181) DUMP TESTS FOR CHARGING NPR FUEL ELEMENTS INTO AN ANNULAR DISSOLVER. M. Clement, comp. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation. July 7, 1964. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Eleven dump tests involving 450 simulated NPR fuel elements were successfully made into a 10½-inch mock-up annular dissolver. All dumps were made without any fuel elements wedging between the walls of the annulus. The tests demonstrated that the 24-inch long NPR fuel element can be dumped into the 12-inch annular dissolver planned for Purex. Further tests are planned to explore the effects of smaller annulus sizes required for higher ^{235}U enrichment levels. (auth)

15669 (JINR-E-1921) ANION EXCHANGE ADSORPTION OF GADOLINIUM AND EUROPIUM FROM AQUEOUS-METHANOL SOLUTIONS CONTAINING NEUTRAL NITRATES. F. Molnar, A. Horvath, V. A. Khalkin, and V. A. Volkov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1964. 17p. Dep. (mn).

The anion exchange behavior of gadolinium and europium was investigated in aqueous methanol solutions containing neutral nitrates. Eluants containing methanol and neutral nitrates were found to allow the anion exchange separation of rare earths. Preliminary data are presented on a method for separating light rare earths from gadolinium targets irradiated with 680 Mev protons. (auth)

15670 (KFK-233) SILIKAGEL ALS AUSTAUSCHADSORBENS. LITERATURUBERSICHT. (Silica Gel as Exchange Adsorbent. Literature Survey). Wolfgang Bannasch and Hans-Heiko Stamm (Kernforschungszentrum, Karlsruhe (West Germany)). Institut fur Radiochemie. June 1964. 54p. Dep.(mn).

A bibliographic review is presented on the studies made since 1900 on the adsorption and ion exchange of cations from aqueous systems with silica gel. The 115 references are arranged alphabetically and each has a brief abstract on the contents of the article. Author and subject indexes are included. (J.S.R.)

15671 (ORNL-TM-972) PROPOSED DESIGN OF A FLUIDIZED-BED FLUORIDE-VOLATILITY PILOT PLANT FOR INSTALLATION AT OAK RIDGE NATIONAL LABORATORY. R. P. Milford (Oak Ridge National Lab., Tenn.). Oct. 26, 1964. Contract [W-7405-eng-26]. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Plans for a fluidized-bed fluoride-volatility pilot plant proposed for installation in Building 3019 are presented. The facility will be used to demonstrate the separation of plutonium and uranium from fission products in low-enrichment power-reactor fuels, and the recovery of plutonium. The major operations to be performed in the pilot plant are: (1) decladding, (2) fluorinating, (3) condensing the mixed volatile fluorides, and (4) preparing the product. (D.L.C.)

15672 (USNRDL-TR-804) RAPID SEPARATION OF INDIUM FROM TIN BY SUBLIMATION. FORMATION OF In^{121} IN FISSION OF U^{235}. H. V. Weiss and N. E. Ballou (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 30, 1964. Contract AT(49-2)-1167. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A 0.5-minute procedure was developed for the separation of indium from tin. The method depends upon the formation of indium acetylacetonate and its subsequent purification from coprecipitated tin by sublimation. This scheme was applied to the study of the formation of ^{121}In in the neutron irradiation of ^{235}U. The results of irradiation experiments confirmed the formation of an ^{121}In isomer with a half-life of 3.1 ± 0.3 min. The cumulative fission yield of this isomer was 3.2×10^{-5}%. Moreover, evidence was found that the yield of fission-formed ^{121}In isomers depends upon precursors. (auth)

15673 (AEC-tr-6543) MULTISTAGE LABORATORY EXTRACTION INSTALLATIONS FOR THE SEPARATION OF RARE EARTH ELEMENTS. G. V. Korpusov, Yu. S. Krylov, and E. P. Zhirov. Translated from p.211-23 of "Redkozemel'nye Elementy," (a publication of the Institute of Geochemistry and Analytical Chemistry of the V. I. Vernadskii, Academy of Sciences, U.S.S.R., Moscow, 1963). 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL.

Several types of extraction units are described: (1) countercurrent glass extractor with air mixing, (2) countercurrent unit with screw mixers, (3) box-type countercurrent mixer-settling tank extractor, (4) semi-countercurrent cell with air mixing of immobile heavy phase, and (5) semi-countercurrent unit with mechanical mixing of immobile heavy phase. (D.L.C.)

15674 THE SOL-GEL PROCESS. G. C. Wall (Australian Atomic Energy Commission Research Establishment). At. Energy Australia, 8: No. 1, 2-9(Jan. 1965).

The Sol-Gel process, which converts uranium and thorium nitrate solutions to high-density oxides, is described. Since the Sol-Gel process can be carried out behind radiation shielding, there is no need for almost complete removal of fission products from the fuel. A single solvent extraction cycle giving a decontamination of 10^3 or even less appeared to be satisfactory when the Sol-Gel process was used. The process is described and a flowsheet presented. It produces ceramic fragments of spheres of nearly theoretical density without the application of pressure and at temperatures much below the accepted sintering point. The process consists of steam denitration, dispersion to sol, spray spheroidization, sieving, drying, and sintering at 1150°C in hydrogen. Studies are being made of the preparation of beryllium oxide by this method. (M.C.G.)

15675 PAPER CHROMATOGRAPHY OF RARE EARTH ELEMENTS WITH ALKALI METAL SALT-IMPREGNATED FILTER PAPER. Hideo Nagai and Mutsukazu Kamo (Kumamoto Univ., Japan). Bunseki Kagaku, 14: 33-7(Jan. 1965). (In Japanese)

Nitrates of some rare earth elements {Y, La, Ce(III), Pr, Nd, Er, and Yb} were chromatographically developed on filter paper strips impregnated with alkali metal salts. Separation abilities were examined for couples of these elements, and the chromatograms obtained showed less tailings and better separations than those by the conventional chromatography. The filter paper was impregnated with 40 to 50 mg/ml solution of sodium chloride or potassium chloride and dried. The best result of mutual separation of rare earths ions was obtained when they were developed with a mixture of 200 ml of water-saturated n-butyl alcohol, 20 ml of glacial acetic acid, and 10 g of oxine. (auth)

15676 EXCHANGE AND EXTRACTION BY LIQUID ION EXCHANGERS. EXTRACTION OF URANIUM, IRON, AND NICKEL. (PART I). Charles Giannotti (Universite, Paris). Chim. Anal., 46: 625-31(Dec. 1964). (In French)

Extractions in the liquid phase by ion exchangers play an important role in the atomic industry and in the region of basic research. The majority of anion extractions use alkylamines with long chains or quaternary ammonium compounds. The extractions by cation exchange are principally by organophosphorus acids and, in certain cases, by sulfonic, carboxylic, and fluorocarboxylic acids. The progress realized in the extraction by anion exchangers in liquid phase such as amines of higher molecular weight are reported. (tr-auth)

15677 SOME OBSERVATIONS ON THE EXTRACTION OF NITRIC ACID BY LONG CHAIN PRIMARY, SECONDARY, TERTIARY AMINES AND BY QUATERNARY AMMONIUM COMPOUNDS. G. Scibona, B. Scuppa, and M. Zifferero (CNEN, Rome). Energia Nucl. (Milan), 12: 85-94(Feb. 1965).

The nature of the benzene solutions of alkylammonium nitrates and of the system alkyl ammonium nitrate-HNO_3-benzene was investigated by infrared spectra, viscosity and conductivity measurements. Equilibrim data on the HNO_3 are also considered. Physico-chemical evidence exists for the complex $R_4N \cdot NO_3 \cdot HNO_3$, where R can be H or alkyl. (auth)

15678 SEPARATION OF VANADIUM AND URANIUM IN FLUORINE-CONTAINING SOLUTIONS BY MEANS OF ANIONITES. V. S. Pakholkov and A. Ya. Korbut. Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., No. 3, 116-21 (1963).

Anionites used for selective adsorption of U(VI) from solutions containing F^- and Cl^- were the strongly basic AV-17, which absorbs practically no V(IV), so that it is sufficient to wash the column with H_2O before desorption of the U(VI); and the polyfunctional anionites EDE-10P and AN-2F, which adsorb a small amount of V(IV). This vanadium is fully extracted by 0.3N HCl containing 5 g of HF per liter. The U(VI) is not eluted by this solution. Since V(V) is adsorbed to a considerable extent by anionites, it is eluted with solutions containing reducing agents (e.g., hydroxylammonium chloride or Na_2SO_3), which reduce V(V) to V(IV). The anionite AV-17 adsorbs U(VI) and V(V) from solutions. 0.1N in HCl and 0.5N in HF. The V is eluted with 0.1N HCl containing 5 g of HF and 10 g of Na_2SO_3 per liter; complete separation of U and V is achieved. Hydroxylammonium chloride is an efficient reducing agent, but is unsuitable because of the evolution of N. The U(VI) is always eluted with HCl. (Analytical Abstr., 12: No. 1, Jan. 1965)

15679 ION EXCHANGE OF Cs AND Rb ON TUNGSTEN FERROCYANIDE. J. Krtil (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 27: 233-6(Jan. 1965).

The sorption of ^{137}Cs and ^{86}Rb on tungsten ferrocyanide was investigated under static conditions. The influence of hydrogen, ammonium, sodium, and cesium ions was studied and the corresponding selectivity coefficients determined. (auth)

15680 METAL COMPLEXES INVOLVED IN SOLVENT EXTRACTION AND THEIR ROLE IN THE SYNERGISTIC EFFECT. W. R. Walker and N. C. Li (Duquesne Univ., Pittsburgh). J. Inorg. Nucl. Chem., 27: 411-17(Feb. 1965).

Solid ternary complexes of the type $M(TTA)_2 \cdot TOPO$ (M = Zn^{2+} and Cu^{2+}, TTA = thenoyltrifluoroacetone anion and TOPO = tri-n-octyl phosphine oxide) were prepared and investigated. The phosphorus nuclear magnetic resonance method was used to determine the equilibrium constant of the reaction $Zn(TTA)_2$ (org.) + TOPO (org.) = $Zn(TTA)_2 \cdot$ TOPO(org.). This was found to be approximately 10 l/mole in anhydrous carbon tetrachloride medium. It was also found that in the same medium, the less basic TBEP (tri-n-butoxyethyl phosphate) did not coordinate with $Zn(TTA)_2$ to any measurable extent. In fact, the corresponding ternary complexes $M(TTA)_2 \cdot$ TBEP could not be isolated. Proton magnetic resonance studies also afford evidence for the reaction: $Zn(TTA)_2 \cdot 2H_2O$ + TOPO = $Zn(TTA)_2 \cdot$ TOPO + $2H_2O$ in carbon tetrachloride medium. It is suggested that the phenomenon of synergism may be due to the enhanced solubility (in the organic phase) of neutral metal chelates caused by adduct formation with ligands such as TOPO. (auth)

15681 INVESTIGATION OF THE COMPLEX FORMED IN THE EXTRACTION OF URANYL NITRATE BY ALKYL AMMONIUM NITRATES. P. R. Danesi, F. Orlandini, and G. Scibona (Comitato Nazionale per l'Energia Nucleare, Rome). J. Inorg. Nucl. Chem., 27: 449-57(Feb. 1965).

The complexes formed between uranyl nitrate and primary secondary tertiary and quaternary ammonium nitrates in suitable diluents were studied by the visible spectra, the dependence of the uranium(VI) distribution coefficient on the alkyl ammonium nitrate molarity, and the saturation of the organic phase, obtained by dissolving uranyl nitrate. The uranium loading in the organic phase as function of the aqueous concentration was also examined. A unique behavior of the loading curve for the tertiary ammonium nitrate was observed. The presence of the organic complexes $RUO_2(NO_3)_3$ for quaternary ammonium nitrate, $RUO_2(NO_3)_3 \cdot (RNO_3)_n$ for tertiary and secondary ammonium nitrates, and $(RNO_3)_n \cdot UO_2(NO_3)_2$ for primary ammonium nitrate with n dependent on the alkyl ammonium salt type is suggested by the results obtained from the different techniques. (auth)

15682 ELUTION OF LANTHANIDES FROM DOWEX-50 BY ACETATE SOLUTIONS. E. H. Ward and G. R. Choppin (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem., 27: 459-62(Feb. 1965).

The separation factors were determined by column elution for Ce, Pm, Eu, Tb, Tm, and Y using Dowex-50 and ammonium acetate solutions. Agreement between the experimental separation factors and those predicted from the stability constants of lanthanide acetate complexes showed that for elution with 1.1M ammonium acetate solution the principal solution phase species is MAc_3 (M = metal ion, Ac = acetate ion) and the principal resin phase species in MAc^{2+}. The separations were not as large as with elution using α-hydroxycarboxylate solutions. (auth)

15683 STUDY OF THE SORPTION OF ZIRCONIUM ON SILICA GEL FROM TRIBUTYLPHOSPHATE SOLUTIONS IN BENZENE. J. Rais, M. Kyrs, and R. Caletka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez.). J. Inorg. Nucl. Chem., 27: 463-72(Feb. 1965).

The main factors influencing the adsorption of tracer amounts of zirconium on silica gel from a benzene solution of tributyl phosphate and nitric acid were investigated. The capture of zirconium depends on the nitric acid and tributyl phosphate concentrations in the organic phase and on the water content in the sorbent. All the experimental results can be interpreted in a qualitative way by the assumption of two capture mechanisms: silica gel acts as a carrier of water re-extracting zirconium and silica gel

adsorbs the zirconium complexes with TBP directly from the organic phase. (auth)

15684 ADSORPTION OF FISSION PRODUCTS ON ALUMINA IN ORGANIC SOLUTIONS. Noboru Oi (Tokyo Shibaura Electric Co., Ltd., Kawasaki-shi, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 335-8(Dec. 1964).

Metal nitrates are readily adsorbed on alumina in organic solutions such as acetone and n-butyl acetate. Adsorption isotherms for such compounds as uranyl nitrate, thorium nitrate, and cerium nitrate(III) were examined and the adsorption was found to have occurred monomolecularly on the surface of the alumina. The weakest adsorption strength on alumina was found to be that of uranyl nitrate, and the adsorbed uranyl nitrate could be substituted very easily by other nitrates such as of fission products. The logarithmic decrease of the Kd values of fission products on alumina with increase of uranyl nitrate concentration in n-butyl acetate was found to correspond to the increase of the solubility of nitrates of fission products (Ce, Sr, and Zr) with increase of uranyl nitrate concentration. (auth)

15685 A LABORATORY INVESTIGATION OF NUCLEAR FUEL REPROCESSING IN CZECHOSLOVAKIA. Stanislav Havelka and Miroslav Kyrs (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 3-8(Jan. 1965). (In Czech)

Several separation methods convenient for spent fuel reprocessing were studied. Extractions with organic extractants (especially organophosphates), sorption on ion exchangers having phosphorus in the functional group, sorption and coprecipitation on a number of inorganic materials, and forming of radiocolloids were investigated. Investigations of separations by fluoride distillation methods were begun. The problems were studied in a laboratory scale at low activity level. (auth)

15686 ION-EXCHANGE SEPARATION OF RARE EARTHS IN MIXED SOLVENTS. Jiri Alexa (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 21(Jan. 1965). (In Czech)

In a system of 4 concentrations of 5 alcohols using elution chromatography with α-hydroxyisobutyric acid as eluting agent the increasing separation factor with increasing alcohol concentration was verified. This effect is explained with help of equilibrium experiments in complex and noncomplex systems in equal medii. Based on Bjerrum's association theory equations were derived enabling the distribution coefficient to be computed in mixed solvents using the value of the distribution coefficient in water. The sorption reaction of rare earths with the active group of the ion exchanger was unaffected since the nonaqueous component caused the decrease of the dielectric constant in the liquid phase. That is why the association of rare earth compounds in the liquid phase increased and, as a result, the concentration of the rare earth ions decreased so that the distribution coefficient decreased too. The difference in association constants of different rare earths increased with decreasing distribution. The separation factor increased too. In systems with higher alcohol concentration, distribution in the solution surrounding the active group of the ion exchanger was diminished, the association of rare earth ions with the active group increased, and the separation factor was lowered. For practical separations it was desirable to use organic compounds having the lowest distribution in low concentration. The effect of long-chain molecules was smaller than that of short-chain or branched ones. (auth)

15687 THE ANALYTICAL APPLICATION OF THE ION EXCHANGE OF URANIUM AND THORIUM IN AQUEOUS AND NON-AQUEOUS SYSTEMS. PART II. J. Korkisch (Universitat, Vienna). Mikrochim. Ichnoanal. Acta, No. 6, 905-42(1964). (In German)

The adsorption behavior of uranium and other elements towards the strongly basic anion exchanger Dowex 1 was studied in mixtures that contained, as complexing agent formic acid, acetic acid, and propionic acid, and chlorinated derivatives of acetic acid. Aliphatic alcohols, acetone, and ether were used as the organic components of the solvent mixtures. Determination of the distribution coefficients of uranium and other elements such as cobalt and nickel in mixtures of various solvent concentration and modification of the complexing agent content or element concentration provided the basis for the development of analytically usable methods for isolation and separation. From the theoretical standpoint, an attempt was made to explain the exhanced adsorption capacity of the resin for uranium and thorium from mixtures of solvents as compared with purely aqueous solutions by taking into consideration the influences exerted on the degree of adsorption by such factors as the chain length of the alcohols and carboxylic acids or their dielectric constants. (tr-auth)

15688 ELECTROPHORESIS OF THE RARE-EARTHS ON ACETYL CELLULOSE. K. Aitzetmueller, K. Buchtela, F. Grass, and F. Hecht (Universitat, Vienna). Mikrochim. Ichnoanal. Acta, No. 6, 1089-96(1964). (In German)

The use of high-tension electrophoresis for the separation of rare earth mixtures in a α-hydroxyisobutyric acid mixture was investigated. The experiments on paper and acetyl cellulose films are described. After separation of the lanthanides, all of the rare earths could finally be separated. The separation times were 15 to 20 min. The possibility of applying this method to the transuranides is briefly discussed. (tr-auth)

15689 SEPARATION PROCEDURE FOR NATURALLY OCCURRING RADIOACTIVE NUCLIDES POLONIUM-210, SULFUR-35, LEAD-210, AND BERYLLIUM-7 WITHIN THE SCOPE OF A GENERAL SEPARATION PROCESS. Markus Stoeppler (Universität, Heidelberg). Nukleonik, 6: 335-40 (Nov. 1964). (In German)

Determination of naturally occurring nuclides in addition to fission products in air filter and precipitation samples requires, in the presence of a considerable fraction of fresh fission products, some effort. During the last nuclear weapon tests, the efficiency of individual separation operations could be tested directly under unfavorable conditions and thus improved. A separation method usable under these conditions was described and the sampling method was explained. Complete directions for the separation and determination of ^{210}Po, ^{35}S, ^{210}Pb, and ^{7}Be are given. (tr-auth)

15690 PURIFICATION OF ORGANIC MODERATORS-COOLANTS FOR NUCLEAR REACTORS. PART II. Giuseppe Basso. Riv. Ing. Nucl., 2: 531-44(Sept.-Oct. 1964). (In Italian)

On the basis of the model assumed for the coolant and the mechanism proposed for the formation of encrustations on fuel elements, criteria for filtration and purification plants for the organic liquids are proposed. The characteristics of distillation, solvent extraction, or adsorption installations for purification were derived. Installations for regeneration of irradiated coolants by catalytic cracking are considered. The experimental programs being initiated in this area are described. (J.S.R.)

15691 SEPARATION OF SOME ELEMENTS ON SILICA COLUMNS TREATED WITH A LIQUID CATION EXCHANGER. A. P. Rao and M. N. Sastri (Andhra Univ., Waltair, India). Z. Anal. Chem., 207: 409-10(1965).

The separation of a number of elements by employing silica columns treated with the liquid cation exchanger dinonyl naphthalene sulfonic acid is described. (auth)

15692 ION EXCHANGE SEPARATION OF METAL IONS WITH THIOCYANATE. A. K. Majumdar and B. K. Mitra (Jadavpur Univ., Calcutta). Z. Anal. Chem., 208: 1-7(1965).

The elution behavior of thiocyanates of Hg, Cu, Cd, Zn, Pb, Bi, Fe, Cr, Co, Ni, Mn, Al, V, Ti, Zr, Th, U, Tl, Ag, and Ba on Amberlite IR-120 and IRA-400 was studied. The results suggested that separation of ions from two or three component mixtures is possible using the anionic resin column. In the cationic column, however, separation of ions from two to five component mixtures was achieved. (M.C.G.)

15693 THE PROCESSING OF STRONG SALT SOLUTIONS BY CONTINUOUS ION EXCHANGE. Irwin R. Higgins (Chemical Separations Corp., Oak Ridge, Tenn.). 18p. (CONF-718-6)

From American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 1964.

The CHEM-SEPS-type continuous countercurrent ion exchange contactor and its operation are described. Examples of typical performance and flowsheets are given for U sorption from strong chloride solutions, regeneration in softening of water, and conversion of KCl into KNO_3, of lime and salt into caustic soda, and of KCl and H_3PO_4 into K_2HPO_4. (D.L.C.)

ENGINEERING

General

15694 (ACNP-64501) ENERGY DEPOT SYSTEM STUDY — LIQUID HYDROGEN AND AMMONIA FUELS. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div. and Air Products, Inc., Allentown, Pa.). Feb. 1964. Contract AT(30-1)-3133. 243p. Dep.(mn); $6.00 (cy), 5(mn) CFSTI.

Three separate energy depot systems are investigated: liquid hydrogen-air, liquid hydrogen-liquid oxygen, and ammonia-air. These fuel production plants (energy depots) are comparable in all cases. Liquid hydrogen is the most efficient; ammonia is the smallest and lightest. Fuel storage and handling units are feasible for all three types, with a small advantage for storing ammonia under pressure. Application of fuel cell drives to an armored personnel carrier and a 5-ton cargo truck is studied, and the fuel cells, their auxiliaries, and the electric drive motor are described. The effect on the two vehicles using the energy depot fuels with the fuel-cell drive unit is analyzed. Of the three systems, the hydrogen-air fuel-cell drive unit produces the lightest, most promising vehicle. The vehicle characteristics are also analyzed when powered by an internal-combustion engine using liquid hydrogen or ammonia as fuel and are compared with fuel cell-powered vehicles. When an internal-combustion engine is used, ammonia is the better fuel. (auth)

15695 (DP-419) ULTRASONIC CLEANING OF LONG ALUMINUM-CLAD TUBES. John G. Thomas, Nicholas Maropis, J. Lloyd Straughn, and Florence R. Meyer (Aeroprojects, Inc., West Chester, Pa.). Nov. 1959. Contract AT(07-2)-1. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Experimentation with several designs of ultrasonic tube-cleaning units indicated that satisfactory cleaning of both internal and external tube surfaces could be achieved with a radially radiating device positioned inside the tubing. Laboratory tests showed accelerated removal of embedded lead-graphite extrusion lubricant from the surfaces of long aluminum or aluminum-clad tubes by drawing this unit through the tube during immersion first in a detergent solution and subsequently in an acid solution. (auth)

15696 (K-L-6018) FLUXLESS INTERNAL SOLDER SEAL FOR METAL TUBING. R. H. Stevens (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 4, 1965. Contract W-7405-eng-26. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A method was developed for sealing systems under vacuum, moderate pressure, or containing materials affected by the presence of flux. Molten solder is poured into a preformed, erect "U" in a tubing connected to the system. Several examples of the use of silver and soft solders with copper tubing are given. (D.L.C.)

15697 (ORNL-P-869) RESULTS OF A TESTING PROGRAM FOR UNIRRADIATED FISSILE MATERIAL CONTAINERS. L. B. Shappert (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 16p. (CONF-650103-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

Containers for the shipment of fissile materials are ordinarily designed such that the container will be subcritical under any conditions of neutron moderation, reflection, or interaction that may credibly occur during the shipment. Subcriticality in the event of interaction with other fissile containers is assured by surrounding individual fissile containers with a rigid framework or buffer that maintains a required degree of spacing between individual containers. One such design employs the use of a 55-gal drum as a buffer or birdcage. The fissile container (or bird) is a section of 8-in.-dia steel pipe centered coaxially in the drum. In the event of a shipping accident, such a framework may be distorted sufficiently to reduce the spacing between two or more containers to unsafe values. Impact tests were made to evaluate the extent of the distortion under simulated accident conditions and to provide guidelines for improvements in birdcage design. It was found that by welding steel braces between the bird and steel bearing bands which are in turn welded to the inner surface of the surrounding drum, the birdcages can withstand at least a 30-ft free fall onto a rigid surface without any significant distortion of the drum or movement of the bird within the drum. (auth)

15698 (UCRL-Trans-1145(L)) INDUSTRIAL METROLOGY — EFFECT OF TEMPERATURE ON THE CALIBRATION OF STANDARDS. Paul Grand. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Rev. Gen. Mecan., 39-40: (1955-56). 92p. Dep.(mn); $8.60(fs), $2.96(mf) JCL.

A study is made of the effects of temperature on the calibration accuracy of standards whose tolerances are between several microns and several hundredths of a mm and may have relative values as low as 8×10^{-6}. Measurement errors due to a variable ambient temperature in the measurement room are calculated. The effects of aging on the lengths of standards are also considered. Criteria for minimizing these errors are outlined. (D.L.C.)

Applications of Nuclear Explosions

15699 MEASUREMENTS AND CALCULATIONS OF PEAK SHOCK-WAVE PARAMETERS FROM UNDERGROUND NUCLEAR DETONATIONS. F. Holzer (Univ. of California, Livermore). J. Geophys. Res., 70: 893-905(Feb. 15, 1965). (UCRL-7805)

Instruments which measure peak shock pressures and shock positions from underground nuclear explosions were developed, and results were obtained from 33 detonations in alluvium, 3 in tuff, and 2 in granite. The measurement techniques in the high-pressure region are so refined that the probability of obtaining meaningful data from any experiment is high. In a parallel effort, a computer calculation was produced by means of which, once the necessary dynamic material properties are known, shock-wave parameters can be calculated as a function of time and a single space variable. For tuff and granite, the difference between most measured peak pressures and calculated values is less than 20%, with poorer agreement in the case of alluvium. Most calculated shock positions agree with measurements to within a fraction of a meter. At least half of the disagreement is due to uncertainty in relating raw data to values in the medium, caused primarily by poor knowledge of the Hugoniots of earth and rock materials and the instrument coupling grout. Large inhomogeneities in the medium near instruments is the most likely explanation for those measurements which disagree by more than 20% with calculated values. (auth)

Facilities and Equipment

Refer also to abstracts 15283 and 15963.

15700 (ATD-P-64-46) MAGNETIC FIELD PRODUCTION. Comprehensive Report. Surveys of Soviet-Bloc Scientific and Technical Literature. (Aerospace Technology Div., Library of Congress, Washington, D. C.). July 1964. 89p. (AD-602730). $3.00(CFSTI).

The production of pulsed and continuous fields is considered; force-free fields are studied; Soviet research on superconductivity is reviewed; and certain aspects of Soviet work on accelerator magnets and magnets for plasma containment is summarized. Current Soviet

trends in high magnetic field production are assessed. (auth)

15701 (USCEC-82-214) ELECTROMAGNETIC RADIATION THROUGH A COLD CYLINDRICAL PLASMA SHEATH WITH AN AXIAL STATIC MAGNETIC FIELD. Cavour W. H. Yeh (University of Southern California, Los Angeles. Engineering Center). Aug. 1963. Contract AF19(604)-6195. 23p. (EE-30; AFCRL-63-347; AD-423426). $2.60(CFSTI).

The expressions for the radiated fields of an arbitrary slot on a conducting cylinder coated with a cold plasma sheath, with an axial static magnetic field, are obtained. It is known from the plane-wave analysis that the presence of a static magnetic field affects the transmission characteristics of the signal through the plasma sheath. The principal concern of this paper is to consider the effects of a static magnetic field on the radiation of a plasma coated slot antenna. Extensive numerical computations are carried out for the special case of an infinite axial slot. It is found that at moderate plasma frequency, a small axial static magnetic field could significantly change the radiation patterns of the slotted antenna. Furthermore, the radiation patterns are asymmetric. (auth)

15702 (FTD-TT-64-442) RADIAL DISTRIBUTION OF CHARGED-PARTICLE CONCENTRATIONS IN A MAGNETIC ION SOURCE. M. D. Gabovich and Yu. B. Ermolovich (Yermolovich). Translated from Ukr. Fiz. Zh., 2: 165-73(1957). 13p. CFSTI.

The results of some experiments on a magnetic ion source are presented. The results show that the increase of magnetic field is accompanied by the appearance of a main discharge column, the radius of which approaches the cathode radius. This column is a plasma pierced by the fast primary electrons. The law of the radial discharge distribution inside the column differs from that outside the column if the magnetic field is large enough. An equation is obtained for radial distribution of the charged particles concentration. It is based on the following assumption: ionization is produced mainly by the fast primary electrons, but the neutralization of the positive space charge takes place chiefly because of the slow electrons; electrons generated in the column leave it because of the radial diffusion weakened by the magnetic field influence; and the ions produced in the column leave it chiefly along the "potential groove" to the ends of the vessel. With some simplification, the radial distribution of the charged particles concentration inside the column can be expressed by an equation. Comparison with experiment confirms the validity of this relation inside the column and makes it possible to evaluate the electron diffusion coefficient in a direction transverse to the magnetic field. With a magnetic field value of $H \approx 460$ Oe this quantity is of the same order as that predicted by Bohm theory. With low field values ($H \approx 50$ Oe the experimentally estimated diffusion coefficient corresponds to the value resulting from laminary diffusion theory. (auth)

15703 A DEMOUNTABLE, BAKEABLE, MECHANICALLY SEALED, VACUUM-TIGHT BERYLLIUM WINDOW. I. C. Demetsopoullos, A. J. L. Collinson, and J. M. Zarzycki (Borough Polytechnic, London). J. Sci. Instr., 42: 39(Jan. 1965).

A simple, mechanical, demountable seal for a thin beryllium window is described, which is suitable for use on bakeable soft x-ray tubes permanently evacuated to 1 to 0; 1 ntorr. (auth)

15704 HANDLING OF RADIOACTIVE SUBSTANCES FOR THERAPY. F. T. Farmer (Royal Victoria Infirmary, Newcastle upon Tyne, Eng.). Proc. Roy. Soc. Med., 57: 352(May 1964).

A dual-purpose lab for handling radium containers and high activity isotopes is described. On the Ra side all operations are carried out behind a 4-in. lead wall. Master-slave manipulators are mounted on an overhead track with a motor drive. A safe is fitted behind the protective wall, and storage drawers, for made-up Ra sources, with electrically operated catches for their open position are built into the back of the bench. Sterilizing by autoclave is carried out before the Ra leaves the bench. The Ra is transferred by a lifting device into a shielded trolley for carriage to the treatment room. On the other side of the lab provision is made for dispensing the commonly used isotopes, both sterile and nonsterile, with a minimum of exposure. Whole-body exposures to staff amount to only a few MR a week with this arrangement. (BBB)

15705 EXPERIMENTAL RESEARCH ON A NON-AXIAL SYMMETRICAL PRESSURE VESSEL. Giorgio Bartolozzi (Universita, Pisa). Riv. Ing. Nucl., 2: 545-65(Sept.-Oct. 1964). (In Italian)

ANCC and ASME standards on the dimensions of the toriconical axial-symmetrical pressure vessel were examined critically with special emphasis on the regular evaluation of elastic field pressures in the connection of the cylinder to the cone. Examinations were made of the theoretical and experimental consequences of the stress state and the elastic field deformation of the pressure vessel. The results obtained experimentally on a heat exchanger with nonaxial symmetrical geometry are reported. The results of experiment and theory are compared. (J.S.R.)

15706 HIGH SENSITIVITY LOW BACKGROUND SYSTEM—DESIGN THROUGH INITIAL RESULTS. Byron Branson, G. J. Karches, H. Kolde, R. K. Stoms, Bern Kahn, and Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). 24p. (CONF-642-18)

From Health Physics Society, Cincinnati, June 1964.

The design, construction, and initial operation of a multipurpose steel room, $12 \times 8 \times 8$ ft and constructed of 5-in. plate, are described. All types of environmental samples—large quantities of inorganic and organic materials and biological samples including small (mice, rats) and intermediate animals (guinea pigs, cats)—and human beings exposed to environmental radioactivity can be counted in this facility. (auth)

15707 A ONE-Mev PULSED X RAY FACILITY FOR SIMULATION WORK. H. F. Rugge (Physics International Co., Berkeley, Calif.). 15p. (CONF-641009-8)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A 1-Mev pulsed x-ray system has been designed and developed as a prompt gamma irradiation facility for simulation work. The system is capable of producing average dose rates of 10^9 r/sec over a volume of approximately 40 in.^{3} and rates of 10^{10} r/sec over 1 in.^{3} The dose, dose rate, angular distribution, spectrum, diagnostics, and apparatus associated with the 1-Mev system are presented. (auth)

15708 REMOTE MANIPULATION APPARATUS. Jean-Claude Eude, Claude Piron, Jean Savouyaud, and Jean Vertut (to Commissariat à l'Energie Atomique). U. S. Patent 3,155,240. Nov. 3, 1964. Priority date Feb. 16, 1960, France.

A remote manipulation apparatus having a manipulation head composed of an arm, a forearm, and a pincer is patented. The head is constructed and arranged for unlimited rotation of the arm, for elbow movement of the forearm with respect to the arm, for unlimited movement of the pincer, and for closure of the pincer. Kinematic linkages through gears and flexible driving shafts transmit these movements. Four motors, one for each movement, are mounted upon the head at maximum distance from the pincer. Speed reducers in each of the linkages adjacent to the output end of the linkage reduce motor speed to the controlled speed of the movement. (A.G.W.)

15709 APPARATUS FOR CUTTING A CASING OF MALLEABLE MATERIAL CONTAINING A SOLID MATERIAL. Maurice Alles, Pierre Camatte, Denis Martin, and Achille Pellerin (to Commissariat à l'Énergie Atomique). U. S. Patent 3,156,394. Nov. 10, 1964. Priority date May 4, 1959, France.

The apparatus described for severing a casing of mal-

leable material containing a solid material is particularly adapted to the cutting of casings of cylindrical elements enclosing radioactive material and having longitudinally extending spaced ribs. A set of clamping jaws disposed in a plane at right angles to the long axis of the casing and a set of shearing jaws in a second plane parallel to and adjacent to the first are moved into engagement with the casing. The shearing jaws are then rotated with respect to the clamping jaws, shearing first the ribs and then the casing in a plane between the two sets of jaws. Means are provided for holding and periodically advancing the casing. The depth of the imprint in the casing wall can be so adjusted that the machine does not contact the irradiated material. The device is controlled by pull rods, which can easily traverse a suitable thickness of lead, concrete, water, or other protective material. (A.G.W.)

15710 SUPERSONIC COMPRESSORS. Fernand Bourquard (to Commissariat à l'Energie Atomique). U. S. Patent 3,156,407. Nov. 10, 1964. Priority date July 7, 1958, France.

A compressor for gaseous fluids has at least one blading through which the relative velocity of the fluid with respect to the blades is higher than the local velocity of sound in some portions of the passages between the blades. Each passage between the blades includes an intermediate zone in which a normal shock wave is produced so that the flow in the passage is supersonic upstream of the intermediate zone and subsonic downstream. The portion of the passage upstream of the intermediate zone is shaped in such a manner as to produce a succession of expansion waves, which accelerate the fluid on its way toward the shock wave. The desired passage shape and the resultant expansion waves are obtained by giving a suitable convexity to a portion of every blade. Stability of the shock wave is thus increased at the cost of a small loss of pressure in the gas flow. (A.G.W.)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstracts 17189 and 17333.

15711 (ANL-6861) THE CONTROL OF CONDENSATION HEAT TRANSFER RATES USING AN ELECTROMAGNETIC FIELD. Ralph M. Singer (Argonne National Lab., Ill.). July 1964. Contract W-31-109-eng-38. 186p. Dep.; $5.00(CFSTI).

The use of an electromagnetic field to control the laminar film condensation of a vapor whose liquid is electrically conducting is proposed and analyzed. The condensate is pumped down a vertical wall by the field (similar to the action of an electromagnetic pump), thus eliminating the necessity of gravity without introducing moving parts. The effect of the parameters $c\Delta T/h_{fg}$, Pr, $g(\rho-\rho_v)/\rho B_0 E_0$, $(E_0/B_0)^2/h_{fg}$, and ζ (dimensionless coordinate) upon the condensate film thickness and the heat transfer rate is studied. It is found that when an electromagnetic field is used, the rate of condensation can be significantly increased over that obtained when only the gravitational field is used. For example, the ratio of the condensation Nusselt number with gravitational and magnetic fields to that with only a gravitational field is about ten for sodium when $c\Delta T/h_{fg} = 0.001$, $B_0 =$ 20 kilogauss, and $E_0 = 10$ volts per inch. (auth)

15712 (BAW-1280-18) SECOND PROGRESS REPORT ON THE MODEL SODIUM-HEATED STEAM GENERATOR. Research Report No. 5455. D. W. Koch (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Dec. 31, 1964. Contract AT(11-1)-1280. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The model was modified to meet the specified design conditions and has been satisfactorily operated for 4000 hours. Results of the examination of the Croloy 2¼ specimen exposed to 980°F sodium for 2000 hours indicate partial decarburization to a depth of approximately 5 mils. Examination of Type 316 specimens after 2000 hours exposure to 1100°F sodium revealed some precipitation of carbides at the inner surface which is attributed to sensitization of the material rather than carburization from an external source. No further change was observed in the Type 316 materials after exposure for 4000 hours. However, decarburization of the Croloy 2¼ specimen had progressed to a depth of approximately 10 mils after exposure for 4000 hours. Test operation is continuing toward completion of the planned 8000 hour program. (D.L.C.)

15713 (CEA-R-2632) PROGRAMME DE CALCUL POUR LES ECOULEMENTS TRANSITOIRES THERMO-PNEUMATIQUES. (Calculation Program for Transitory Thermo-Pneumatic Flows). Didier Costes (Commissariat à l'Énergie Atomique, Saclay, France. Centre d'Etudes Nucléaires). Dec. 1964. 24p. Dep.(mn)

With a view to determining the changes occurring in gas reactors after cooling accidents, a calculation program is established for unidimensional gas flows with pressure drops, heat exchanges, and in certain cases blowing, in a reticulated lattice. Any schematization can be taken into account by the use of a set of indices. This program, of which the FORTRAN list is given, is applied to particular cases of sudden pressure drops in the circuits. The results obtained are in good agreement with those obtained both from the graphical method using the characteristics and from experimental recorded data. (auth)

15714 (EUR-2211.d) GRUNDZUGE DER PROBLEME AUF DEM GEBIET DER BLASEN- UND FILMVERDAMPFUNG. (Survey on Problems in the Field of Nucleate Boiling and Film Boiling). H. Herkenrath and P. Moerk-Moerkenstein (European Atomic Energy Community, (Ispra (Italy). Joint Nuclear Research Center. Dec. 1964. 46p. Dep.(mn)

A survey is presented of the research in the field of nucleate boiling and film boiling. Deliberately, a clear distinction is made between the processes occurring in pool boiling and forced convection boiling. The various kinds of flow patterns associated with the boiling process are discussed in detail. Furthermore, a summary is given of the most important empirical and theoretical relations for the critical heat flux. (auth)

15715 (EURAEC-1085) HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES. Joint Topical Report (CAN-2 and CAN-3). S. Bertoletti, G. P. Gaspari, C. Lombardi, G. Peterlongo, and F. A. Tacconi (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contracts 060-61-7-RDI and 056-62-1-RDI. 144p. (CISE-R-99). Dep.(mn); $4.00(cy), 4(mn) CFSTI.

A review and a discussion is presented of experimental results on the heat transfer crisis with steam–water mixtures in heated ducts obtained at CISE and in various other laboratories in the world. Perturbations affecting the normal trend of data are examined first. A discussion of the nature of the phenomenon follows, leading to the selection of natural parameters. Finally a correlation is developed for tubes and generalized for complex geometries. This correlation is checked against data from various origins and is found adequate in a wide range of specific mass flowrates, pressures, and qualities. (auth)

15716 (EURAEC-1087) FURTHER INVESTIGATION ON TWO-PHASE ADIABATIC ANNULAR-DISPERSED FLOW: EFFECT OF LENGTH AND OF SOME INLET CONDITIONS ON FLOW PARAMETERS. Topical Report No. 14. L. Cravarolo, A. Hassid, and E. Pedrocchi (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7-RDI. 93p. (CISE-R-93). Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Results are given of the experiments carried out at CISE under the CAN-2 Research Program to investigate the effect of length and entrance conditions on some hydrodynamic parameters in the vertical upward flow of two-phase (gas + liquid) mixtures in adiabatic conditions. The quantities investigated were pressure drop, film thickness, and phase and velocity distribution. The measurements were performed with a test section 3.5 m long. The experiments

were carried out under the following conditions: flow: vertical upward (mainly in the annular-dispersed regime); geometry: round conduits 1.5 and 2.5 cm ID; fluids: gas phase: argon, and liquid phase: water and ethyl alcohol; gas flow rate: 15–100 g/cm² sec; liquid flow rate: 20–200 g/cm² sec; temperature: 18–20°C; and pressure: up to 22 kg/cm². (auth)

15717 (NASA-CR-164) INSTABILITIES IN THE FLOW OF BOILING LIQUID. A. H. Stenning and T. N. Veziroglu (Miami Univ., Coral Gables, Fla). Feb. 1965. 18p. $1.00 (CFSTI).

Some preliminary results are presented which were obtained with the Freon-11 one-component two-phase horizontal flow system. In addition to the regular density wave two-phase flow oscillations, two new types of flow oscillations were found and are called thermal and pressure drop two-phase flow oscillations, respectively. Some of the distinguishing features of the new types of oscillations are outlined in detail. (D.L.C.)

15718 (NYO-3114-5) TWO-PHASE FLOW AND BOILING HEAT TRANSFER. Quarterly Progress Report, October–December 1964. G. B. Wallis, J. M. Turner, P. E. Meyer, and D. E. Runge (Dartmouth Coll., Hanover, N. H.). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3114-1. 32p. (EURAEC-1329). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Studies in co-current upwards annular flow are being continued to test the suitability of the parameters $Vg^{*'}$ and $Vf^{*'}$ in correlating annular flow data. These parameters were derived from Vg^* and Vf^* as described in the previous report. Suitable data are being obtained using two tube diameters, various liquids, and pressures in the range 1 to 4 atmospheres. Some data are presented in this report. High pressure data for steam–water systems are being obtained in collaboration with the Argonne National Laboratory. Preliminary work is discussed in this report. The investigation of the stability of a horizontal liquid surface is continuing to study wave formation and the mechanism of droplet entrainment. The apparatus has been modified to improve inlet conditions. (auth)

15719 (TID-21531) MOTION AND HEAT TRANSFER OF DROPLETS AT LARGE REYNOLDS AND PECLET NUMBER. Final Report, February 1965. S. Winnikow and B. T. Chao (Illinois Univ., Urbana). Contract AT(11-1)-1069. 172p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

In the first part of the investigation, the behavior of liquid droplets moving in another liquid was studied at high Reynolds number. In the second part, Chao's analytic results, which were confirmed in the first part, were used to evaluate the temperature field and Nusselt number of a fluid sphere with complete internal circulation moving uniformly at high Reynolds and Péclet number. Nitrobenzene, bromobenzene, chlorobenzene, and nitrotoluene in water were used in the experiments. (D.L.C.)

15720 PHOTOGRAPHIC STUDY OF NUCLEATE POOL BOILING ON A HORIZONTAL SURFACE. R. F. Gaertner (General Electric Research Lab., Schenectady, N. Y.). J. Heat Transfer, 87: 17-29(Feb. 1965).

A photographic study was made of saturated nucleate pool boiling at a pressure of one atmosphere. Over 1000 still photographs and 12 high-speed motion pictures were taken of water boiling from a 2-in.-dia flat horizontal surface facing upward. Two surfaces are studied, a 2/0 polished platinum surface and a 4/0 polished copper surface. The platinum surface was studied in the heat flux range of 14,700 to 176,000 Btu/hr-ft², and the copper surface from the incipient boiling heat flux of 10,500 Btu/hr-ft² to the maximum flux of 493,000 Btu/hr-ft². Data were obtained for the breakoff diameters of discrete bubbles, and for the populations of active sites at heat fluxes up to 58,600 Btu/hr-ft². At least three, and possibly four, heat-transfer regions were found to exist in nucleate boiling, depending upon the mode of vapor generation. The vapor structures on the surface progressed through a sequence of discrete bubbles, vapor columns and mushrooms, and finally vapor patches, as the surface temperature was increased. These individual vapor structures, or combinations of them, determine the mechanism of heat transfer in the four nucleate boiling regions. It was concluded that any heat-transfer model or design equation, which is based on the dynamics of individual bubbles, or on any other single mechanism, must be in serious error. (auth)

15721 A STUDY OF FORCED CONVECTION HEAT TRANSFER TO SUPERCRITICAL HYDROGEN. H. L. Hess and H. R. Kunz (United Aircraft Corp., East Hartford, Conn.). J. Heat Transfer, 87: 41-8(Feb. 1965).

Hydrogen heat-transfer data in the supercritical region was compared with an analysis based on fully developed turbulent pipe flow with variable fluid properties. The comparison indicated an additional variable property effect not included in the analysis. However, this approach led to the correlation of the data over the full range of experimental conditions. These results indicated that the mechanism of supercritical heat transfer with hydrogen can be explained on the basis of variable fluid property effects without postulating a new mechanism for heat transfer, as done in previous investigations. It was also found that the pipe flow equation with fluid properties based on the film temperature can be made to correlate the data by correcting the calculated values with a simple function of wall to bulk kinematic viscosity ratio. This method provided a rapid means for determining supercritical hydrogen heat transfer with accuracy sufficient for most purposes. (auth)

15722 AN ANALYTICAL SOLUTION OF THE EFFECT OF PERIPHERAL WALL CONDUCTION ON LAMINAR FORCED CONVECTION IN RECTANGULAR CHANNELS. R. Siegel and J. M. Savino (Lewis Research Center, Cleveland). J. Heat Transfer, 87: 59-66(Feb. 1965).

A study was made of fully developed laminar forced convection in rectangular channels heated on the broad sides. The analysis determined the effect of peripheral heat conduction within the heated walls on the wall temperature distributions. The unheated short side walls were assumed nonconducting. The heat conduction within the broad walls was formulated in terms of an integral equation and coupled with the convective energy equation within the fluid. Analytical solutions were obtained where the heating extended over the entire width of the broad side, was removed from the corner region, or extended beyond the corner into the side wall. Transverse wall conduction produced substantial decreases in the peak wall temperature and in the temperature gradients along the long side. (auth)

15723 GROWTH AND COLLAPSE OF BUBBLES IN NUCLEATE BOILING. Kaneyasu Nishikawa and Hisao Kusuda (Kyushu Univ., Fukuoka, Japan). Nippon Kikai Gakkai Rombunshu, 30: 989-94(Aug. 1964). (In Japanese)

In order to clarify the dependence of bubble growth and collapse upon the shape and size of the heating surface, experiments were carried out with heating surfaces consisting of horizontal circular brass plates 10 cm and 14 cm in diameter, respectively, and horizontal small platinum wire 0.5 mm in diameter. It was found that bubble growth and collapse are independent of heat flux. Bubble collapse is strongly influenced by the degree of subcooling. Bubble growth and collapse, which essentially dominate boiling heat transfer, are considerably affected by the size of heating surface. It may be concluded that one must be careful of applying the experimental results with a heating surface of a size smaller than bubble diameter to boiling with a larger heating surface. (auth)

15724 CORRECTION TO AN EXPRESSION FOR THE THERMAL DIFFUSION COEFFICIENT. L. S. Kotousov (Leningrad Polytechnic Inst.). Zh. Tekhn. Fiz., 34: 2196-8 (Dec. 1964). (In Russian)

In an earlier derivation of an expression for the thermal diffusion coefficient it was assumed that the mean mass velocity in the narrow tube connecting the two large gas volumes is a constant quantity, independent of the tube

length. Accordingly, there were used the average values (over the length of the tube) of the partial and total densities. The question of the pressure differential effect and the flow compensating the difference between the mass flows from one vessel to the other were recently discussed. In this analysis it was found that under quasistationary conditions the center of mass velocity is a function of the coordinate along the tube axis. Accordingly, there is deduced a correction to the earlier formula, taking this factor into account. The final expression is $\alpha_T = [(\partial^2\bar{H}/\partial x_1^2)/(\partial^2\bar{H}/\partial x_1\partial T)]\ (\lambda/nD_{12})\ [1/x_1(\partial\mu_1/\partial x_1)]$ where α_T is the thermal diffusion coefficient, $\bar{H}$ is the molar enthalpy of the mixture, T is the absolute temperature, D_{12} is the interdiffusion coefficient, μ_1 is the chemical potential of the first component, and x_1 is the molar fraction. The role of the pressure gradient in derivation of the expression for α_T is discussed briefly; it is noted that for large diameter tubes the pressure gradient should be negligible. (ATD)

15725 MODERN DEVELOPMENTS IN HEAT TRANSFER. Warren Ibele, ed. New York, Academic Press, 1963. 502p.

Fourteen papers presented at heat transfer lectures at the International Heat Transfer Conference, University of Minnesota, Aug. 1961, are given. Topics covered include: noncircular duct convective heat transfer, heat transfer from chemically reacting gases, ablation cooling, heat transfer with boiling, similarities between energy transport in rarefied gases and by thermal radiation, calculation of radiant interchange between surfaces, thermal radiation properties of solids, heat transfer research in Japan, measurements of the thermal contact resistance from stainless steel to liquid sodium, viscosity of water and steam at high pressures and temperatures up to 800 atm and 700°C, high-temperature thermodynamic properties, gas-surface interaction in an enthalpy-composition chart, anode energy balance of high-intensity arcs in argon, and recent developments in plasma heat transfer. Separate abstracts were prepared for 3 papers. (M.C.G.)

For abstracts of individual papers see: 15726, 16186, and 17141.

15726 HEAT TRANSFER WITH BOILING. Warren M. Rohsenow (Massachusetts Inst. of Tech., Cambridge). p.85-158 of "Modern Developments in Heat Transfer." New York, Academic Press, 1963.

The process of evaporation with bubble formation in heat transfer is discussed. Topics covered include: evaporation on a free liquid surface without boiling, regimes in boiling, heat transfer correlation, nucleation, gas nucleation in bulk liquid, nucleation in boiling, growth of bubbles for a pure fluid, bubble motion at a heating surface, bubble motion observations, heat transfer rates in pool boiling, correlation of pool-boiling heat transfer data, forced convection boiling correlation, maximum heat flux or burnout, and burnout due to flow instability. (106 references). (M.C.G.)

Materials Testing

Refer also to abstracts 15971, 17377, and 17378.

15727 (HW-8A-3379) NEW-EMISSIVITY INDEPENDENT INFRARED THERMAL METHOD FOR NONDESTRUCTIVE TESTING. Donald R. Green (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 20, 1964. Contract AT(45-1)-1350. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A new emissivity independent infrared thermal method of nondestructive testing was developed. The outer surfaces of test pieces were scanned with a heat source and two infrared radiometers. To obtain the emissivity independent output, the signal from one radiometer was delayed, a constant signal was added, and the resulting sum was divided by the second radiometer output. Experimental results were obtained on cylindrical aluminum-clad uranium test pieces having hammer dented, tempera painted, and polished areas in some surface regions. Heat transfer flaws, produced by .003 inch thick mica disks ½ and ⅜ inch in diameter in the aluminum-to-uranium bonds, were detected in the test pieces regardless of surface conditions. Theoretical and experimental results show that the new method can be advantageously applied to test pieces having rough surfaces. (auth)

15728 RADIOGRAPHY WITH NEUTRONS. Willy Marth (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 6: 357-67(Nov. 1964). (In German)

A survey on the present state of neutron radiography is given. By comparison of the mass attenuation coefficients of the elements, the differences from classical x-ray and gamma radiography are shown. The major experimental techniques, the common neutron sources, and the optical image formation properties of different detector arrangements are explained fully. A discussion on the practical application possibilities of neutron radiography and a literature compilation are included. (tr-auth)

15729 THE NEUTRON RADIOGRAPHY OF URANIUM AND LEAD. A. W. Schultz and W. Z. Leavitt [Watertown Arsenal, Mass.]. 20p. (CONF-662-3)

Metals/Materials Congress, Philadelphia, Oct. 1964.

A detailed analysis of the neutron radiography of uranium and lead is presented. A method for calculating penetrameter sensitivity in these materials is described and the results are compared with those obtained experimentally using reactor neutrons and an indium foil-film detection system. A penetrameter sensitivity of 2-2T was obtained for thicknesses ranging from 2 to 4 inches for uranium and 2 to 6 inches for lead. (auth)

15730 RADIOACTIVE MAGNETIC FLAW DETECTION COMPOSITION AND PROCESS FOR MAKING SAME. Zenon Kazenas and Richard A. Ward (to John D. Steele). U. S. Patent 3,155,622. Nov. 3, 1964. Filed Aug. 3, 1959.

A radioactive paramagnetic powder for use in magnetic methods of nondestructive testing may be made by dispersing a powdered paramagnetic material and a carrier material for radioactive elements in a resin prior to final solidification of the resin, solidifying the resin, and grinding to a fine powder. The powder may be immediately or later dispersed in a fluid dispersion of radioactive material to bond the radioactive material and the carrier material together. A fluorescent dye may also be added to make the particles both radioactive and fluorescent. The carrier component may be either a chelating material or a resinous ion-exchange material. The radioactive material may be ^{137}Cs, ^{60}Co, ^{204}Tl, ^{147}Pm, ^{144}Ce, ^{152}Eu, ^{154}Eu, ^{46}Sc, or ^{198}Au in either positive or negative ion form. (A.G.W.)

Protective Structures

15731 (USNRDL-TR-618) ENVIRONMENTAL STUDIES OF A 100-MAN UNDERGROUND SHELTER. R. H. Heiskell (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 1, 1963. 72p. (AD-422534). $7.60(CFSTI)

Tests were conducted to determine the adequacy of the NRDL 100-man shelter to maintain comfortable living conditions for at least 14 days. Temperature studies were conducted during both simulated and human occupancy. The temperature of the shelter remained comfortable during 14 days of human occupancy. The ventilating air movement through the shelter designed for 16 cfm per occupant was adequate to reduce the carbon monoxide concentration from heavy smoking to below safe tolerance limits and it removed 69% of the heat generated by the occupants with only 31% of the heat being dissipated through the walls. The shelter temperature varied between 74 and 90°F with an outside air temperature of 50 to 94°F during the simulated occupancy test and between 70 and 82°F during the human occupancy tests with an outside air temperature of 36 to 67°F. Poor distribution of the inlet air resulted in uncomfortably cool areas in the front of the shelter during the human occupancy test. A preliminary analysis was conducted on a thermal analyzer to determine its potential as a tool for predicting shelter temperatures under various climatic conditions. This analysis showed only

about 10% deviation from the measured temperature reported. (auth)

15732 THE FIRST NUCLEAR AGE HOSPITAL WITH A SURVIVAL COMPLEX. W. Palmer Dearing (Office of Civil and Defense Mobilization, Washington, D. C.). Hosp. Management, 90: 37-8(Aug. 1960).

The construction of hospitals with provisions for treating casualties of a nuclear war, and protected from blast and fallout by underground facilities, as well as some general topics relating to civil defense are discussed briefly. Vital facilities of the hospital described are located on two floors underground. These facilities will thus be protected against radioactive fallout according to the design and structural recommendations of the Office of Civil and Defense Mobilization. In addition to the surgery, pathology, radiology departments, central supply, pharmacy, and food service, the protected facility will accommodate the patients and staff of the entire 750 beds being constructed above ground. With its own safeguarded air, water, and power supplies, 1200 people can occupy it for more than two weeks. (BBB)

15733 NUCLEAR AGE HOSPITAL DESIGN. Charles U. Letourneau and William D. Hamrick. Hosp. Management, 90: 39-41(Aug. 1960).

Plans for the construction of a 750-bed hospital that will incorporate two underground levels for fallout protection are described and illustrated. This survival complex is being constructed as a shelter against fallout radiation according to the specifications of the Office of Civil Defense Mobilization. The vital services, being housed in two floors underground, include x ray, laboratories, central service, surgical operating room, recovery room, kitchen and dining room, stores, emergency service, and large areas of storage space equipped with oxygen and suction outlets for use in a disaster. The survival complex is designed to enable hospital personnel and patients plus a limited number of others to maintain themselves for 14 days in complete safety even though the entire outside area be destroyed or saturated with lethal radiation levels. Standby electric generator equipment will be included in the complex and the hospital will have special wells drilled into the survival complex so as to give an adequate supply of water for drinking, washing, cooling and decontamination in the event of destruction of the city water mains. The position of the decontamination unit is such that, in the event of attack, it would not be manned by hospital personnel but by specially trained civil defense experts in decontamination and radiation safety. The emergency area is entered via the upper level of the survival complex. In the event of atomic attack, leaded radiation-proof doors will slide into position sealing off the survival complex completely. They will be opened to admit patients only upon the instructions of the officer in charge of civil defense protection. (BBB)

Space Propulsion

See also REACTOR TECHNOLOGY — Propulsion and Space.

Refer also to abstracts 16444, 17346, 17347, and 17350.

15734 SPACE NUCLEAR PROPULSION, MID-DECADE. Harold B. Finger (AEC NASA Space Nuclear Propulsion Office). Astronaut. Aeronaut., 3: No. 1, 30-5(Jan. 1965).

Developments in space nuclear propulsion systems are reviewed; included are solid-core rocket reactors, electric propulsion systems, gaseous-core rocket reactors, liquid-core rocket reactors, and pulse-propulsion systems (Orion). (R.E.U.)

15735 INTERPLANETARY FLIGHT WITH ELECTRIC PROPULSION. William R. Mickelsen and John S. Mackay (Lewis Research Center, Cleveland). Astronaut. Aeronaut., 3: No. 1, 44-9(Jan. 1965).

Mission requirements for various electric propulsion schemes are reviewed with special emphasis on hybrid systems, e.g., electrically propelled spacecraft boosted to hyperbolic velocity by nuclear or chemical stages. Both manned and unmanned missions are considered. 31 references. (R.E.U.)

15736 A STEP TOWARDS NUCLEAR-ELECTRIC PROPULSION. Jack Davis (Electro-Optical Systems, Inc., Pasadena, Calif.). Astronaut. Aeronaut., 3: No. 1, 50-1 (Jan. 1965).

The successful testing of a cesium-ion contact engine in space is reported, and future prospects in electric propulsion are discussed. (R.E.U.)

15737 DRAG AND PROPULSION OF LARGE SATELLITES IN THE IONOSPHERE. AN ALFVEN PROPULSION ENGINE IN SPACE. S. D. Drell, H. M. Foley, and M. A. Ruderman (Inst. for Defense Analyses, Arlington, Va.). Phys. Rev. Letters, 14: 171-5(Feb. 8, 1965).

The power dissipated by a conductor in a magnetized plasma in the form of Alfven waves is investigated, with particular consideration of the Echo I satellite. The possibility of converting the drag force to a propulsion mechanism by using a source of electric power to reverse the current flow is also considered. (D.C.W.)

15738 ION ACCELERATION DEVICE. Edmund C. Lary, Russell G. Meyerand, Jr., and Frank Salz (to United Aircraft Corp.). U. S. Patent 3,155,858. Nov. 3, 1964. Filed May 28, 1962.

An ion acceleration device suitable for generating thrust for propulsion in space is patented. The device includes a cylindrical walled casing having an open end, a centerbody mounted within the casing and extending toward the open end, a source of ions within the casing, a source of electrons adjacent to the open end of the casing, and means for establishing a semipermeable membrane to allow acceleration of the ions downstream toward the open end of the casing and inhibit motion of electrons upstream in the casing. The ion source consists of a porous W element and a source of Cs gas in communication with the W element. The electron source is a grid connected to the centerbody. The semipermeable membrane is created by the interaction of an electric field extending along the axis of the casing and a magnetic field extending radially from within the casing to the cylindrical wall. Ions from the ion source are accelerated by the electric field and discharged through the open end of the casing to produce thrust. Electrons from the grid provide space-charge neutralization. Efficiencies of 80% or greater are expected. (A.G.W.)

Vacuum Engineering

Refer also to abstract 16296.

15739 ZEOLITE GETTERING FOR THE PRODUCTION OF AN ULTRAHIGH VACUUM. Thomas H. Batzer and Robert H. McFarland (Univ. of California, Livermore). Rev. Sci. Instr., 36: 328-30(Mar. 1965). (UCRL-12031)

During the past four years, two groups at the Lawrence Radiation Laboratory have extended, independently, the uses of zeolite gettering devices toward the production of an ultrahigh vacuum. The results are discussed. (auth)

15740 STUDIES FOR ELIMINATING GAS RESIDUALS FROM ULTRAHIGH VACUUM SYSTEMS. Éva Rieger (Research Inst. for Technical Physics, Budapest). p.309-20 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963.

Various methods of producing and maintaining ultrahigh vacuum systems were investigated. The residual gas spectra were examined with an omegatron as a partial-pressure gauge. Possibilities of eliminating gas residuals are discussed. (auth)

15741 AN ALL METAL LOW-ENERGY ELECTRON DIFFRACTION VACUUM SYSTEM. C. W. Caldwell, Jr. (Bell Telephone Labs., Inc., Murray Hill, N. J.). 12p. (CONF-640903-4)

From American Vacuum Society Symposium, Chicago.

An all-metal vacuum system designed for diffraction

study of solid surfaces with low-energy electrons is described. The system is compared with a prototype glass system. (D.C.W.)

15742 A LIQUID HELIUM CRYOPUMPED VACUUM SYSTEM FOR PRACTICAL ATTAINMENT OF PRESSURES BELOW 10^{-12} TORR. Raymond W. Moore, Jr. (Arthur D. Little, Inc., Cambridge, Mass.). 10p. (CONF-640903-9)

From American Vacuum Society Symposium, Chicago.

A vacuum system is described in which outgassing from the walls of the vacuum chamber is minimized by cooling the walls to about 80°K with liquid nitrogen and in which high pumping speeds are provided by a cryopumping surface in the chamber maintained at 2.5 to 4.2°K. (D.C.W.)

15743 DESIGN OF LARGE 10^{-12} TORR SYSTEMS WITH ION-GETTERING AND CRYOPUMPING. R. A. Wolf and R. D. Olmstead (Ultek Corp., Palo Alto, Calif.). 27p. (CONF-640903-6)

From American Vacuum Society Symposium, Chicago.

The design and development of methods using ion gettering and cryopumping to achieve pressures in the 10^{-12} torr range in large space simulation chambers is discussed. A bakeable, all-metal chamber 10 ft in diameter and isolated from ambient pressure conditions is described, together with the design and performance of smaller chambers. The factors relating to ion pump configuration, titanium sublimation, and cryopump array design are discussed. (D.C.W.)

15744 AN ULTRAHIGH VACUUM CRYOSORPTION PUMP. J. R. Pitlor and J. P. Simson (Union Carbide Corp., Tonawanda, N. Y.). 24p. (CONF-640903-10)

From American Vacuum Society Symposium, Chicago.

A liquid helium cooled cryosorption pump attaining pressures in the 10^{-12} Torr range is described. Steady-state pumping speeds near the theoretical maximum were measured for most of the components of air, but were found to decrease at higher pressures. A theoretical analysis is presented, relating the pumping speed and operating pressure to the equilibrium isotherm. Linde Molecular Sieve bonded to a liquid helium cooled surface is used for adsorbing uncondensed gases, while surfaces cooled by the vaporized helium cryopump other gases. (auth)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 17315.

15745 NOBLE GAS ANOMALIES IN THE MINERAL THUCHOLITE. D. D. Bogard, M. W. Rowe, O. K. Manuel, and P. K. Kuroda (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 70: 703-8(Feb. 1, 1965).

Unusually high concentrations of noble gases in Besner Mine, Ontario, thucholite were observed. The highest concentrations of noble gases observed in terms of 10^{-6} cm^3 STP/g mineral in five samples of thucholite were as follows: He, 18,500; Ne, 753; Ar, 13,900; Kr, 114; and Xe, 206. It appears that the carbon rich mineral contains common noble gases which represent a very old atmosphere. The isotopic compositions of noble gases in the mineral were modified during the geological history by the following nuclear processes: spontaneous fission of ^{238}U, nuclear reactions such as $^{35}Cl(\alpha,p)^{38}Ar$, $^{18}O(\alpha,n)^{21}Ne$, $^{19}F(\alpha,n)^{22}Na$, and the decay of ^{40}K. (auth)

15746 ANALYSIS OF A GROUNDWATER ANOMALY CREATED BY AN UNDERGROUND NUCLEAR EXPLOSION. Joseph B. Knox, Donald E. Rawson, and John A. Korver (Univ. of California, Livermore). J. Geophys. Res., 70: 823-35(Feb. 15, 1965). (UCRL-7674)

The anomalous groundwater mound and resulting flow regime associated with the Aardvark underground nuclear explosion were examined. The initial anomalous groundwater mound was estimated to be about 200 m high and 250 m in radius with a central depression. The major mechanism for mound development was probably compaction of nearly saturated rock surrounding the explosion. Results of the calculations indicate that water first flowed into the collapsed zone, then radially outward with early velocities approximately 200 times preshot flow velocities. After about 400 days, the magnitude of the anomalous flow had declined to or below the magnitude of the preshot groundwater flow rates. Ideally "traced tagged" water particles initially near the edge of the collapsed zone are estimated to have moved outward about 6.2 m during the first 100 days after the explosion. It is shown that the anomalous mound does not significantly increase the migration of radionuclides from this explosion environment. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 15747, 15800, 15852, 15876, and 16246.

15747 (ACRH-102) THE CONSEQUENCES OF INGESTION BY MAN OF REAL AND SIMULATED FALLOUT. George V. LeRoy, John H. Rust, and Robert J. Hasterlik (Argonne Cancer Research Hospital, Chicago, Ill.). [1963]. Contract AT(11-1)-69. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Real and simulated particulate fallout and solutions of $^{85}SrCl_2$ and $^{134}CsCl_2$ were fed to 102 healthy volunteers. Absorption and retention of ingested radioactivity was measured by whole-body counting. An average of 3 per cent of the radioactivity of week-old local fallout was absorbed: the range was 0 to 9 per cent. Strontium and cesium leached or dissolved from simulated fallout behaved in the same way, metabolically, after absorption as they did when the tracer was swallowed in a solution or injected intravenously. The large number of subjects studied provided additional information on the range of variation of intestinal motility, biological availability of strontium, cesium and barium following ingestion of fallout, and retention of the radionuclides of these elements. (auth)

15748 (AWRE-O-7/65) THE EVALUATION OF CASCADE IMPACTORS DURING OPERATION ROLLER COASTER. D. M. C. Thomas (Atomic Weapons Research Establishment, Aldermaston, (England)). Feb. 1965. 17p. Dep.(mn); $0.50(BIS); 2s. 6d. (HMSO).

Calibration parameters for the Casella and Andersen impactors have been agreed between the US and UK parts of the Operation Roller Coaster teams; the parameters most suited for use in evaluating the data are the characteristic diameters; agreed values of these for both instruments and of the MMD's for the Casella are given. Neither instrument will necessarily give a correct measure of the airborne conconcentration of the larger particles (greater than about 50μ) because of orifice effects and in addition there are losses at the first jet plates of the Andersen instrument. In a comparison of the Casella and Andersen data and the estimation of a complete size distribution of the airborne material, other information, such as that obtained with the cylindrical collectors, must be taken into account. (auth)

15749 (AWRE-O-11/65) SOLUBILITY OF THE PLUTONIUM CONTENT OF PARTICULATE MATERIAL COLLECTED DURING OPERATION ROLLER COASTER. A. P. Ballance and B. J. Wells (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1965. 7p. Dep.(mn); $0.30(BIS); 1s. 2d. (HMSO).

The results indicate that the saturated solution concentration as measured beyond the membrane for these samples is of the order of 10^{-4} μg/ml. This result is in agreement with the solubility in distilled water of pH 5.7 of plutonium oxide obtained by the oxidation of the pure metal at 120°C. The increase in solubility produced by the addition of chelating agents is markedly less than observed with plutonium oxide. (auth)

15750 (NP-14720) STATISTIKA POYAVLENIYA "GORYACHIKH" CHASTITS V PRIZEMNOM SLOE VOZDUKHA V PODMOSKOV'E V 1961-1962 GG. (Statistics of the Appearance of "Hot" Particles in Ground-Level Air Near Moscow in 1961 and 1962). S. G. Malakhov and K. P. Makhon'ko (Gosudarstevennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. 7p. Dep.(mn).

Tabulated data are given of the "hot" particle concentrations in the ground level air near Moscow measured from September 1961 till December 1962. A separate table is given for May–July and Sept.–Oct. 1962. The radioactivity during May–July and Sept.–Oct. 1962 was of the order of 10^{-12} C/particle. The half life of hot particles was about 30 to 40 days. (R.V.J.)

15751 (NP-14776) FEDERAL RADIOLOGICAL FALLOUT MONITORING STATION DIRECTORY. (Office of Civil Defense, Washington, D. C.). Jan. 1964. 255p. (FG-E-5.11).

A list is presented of radiological fallout monitoring stations in the United States. (C.H.)

15752 (NP-14778(Pt.I)) OFF-SITE SURVEILLANCE PROGRAM. PART I. ACCOUNT AND DESCRIPTION OF PUBLIC HEALTH SERVICE SUPPORT ACTIVITIES. 1962 Pacific Nuclear Tests (Operation DOMINIC), March 1962 to November 1962. (Public Health Service, Washington D. C. Div. of Radiological Health). 61p.

The Phase I and II operations of Operation DOMINIC are described, and the events and surveillance station locations are listed. Tables are presented of external gamma radiation levels, gross beta activity in air, and water and precipitation analyses. Results of special air missions are also given. (D.L.C.)

15753 (NP-14778(Pt.II)) OFF-SITE SURVEILLANCE PROGRAM. PART II. MONITORING TECHNIQUES, LABORATORY PROCEDURES AND REPORT OF FINDINGS. 1962 Pacific Nuclear Tests (Operation DOMINIC), March 1962 to November 1962. (Public Health Service, Washington, D. C. Div. of Radiological Health). 58p.

Monitoring techniques, sampling processing, instrument calibration, and laboratory procedures are described. Laboratory results (gross beta activity of air, precipitation, and water) are presented for each of the off-site stations on a daily basis. (D.L.C.)

15754 (NP-14781) RADYOAKTIF YAGISLAR VE BU YAGISLARLA KIRLENMIS SULARIN TEMIZLENMESI. (Radioactive Fallout and Purification of the Water Contaminated by the Fallout). Cemil Senvar and U. Yuecelik (Atomic Energy Commission, Ankara (Turkey)). 1963. 10p. Dep.(mn)

The phenomena involved in radioactive fallout and its effects are reviewed. After the Russian atmospheric atomic bomb tests, radioactive fallout studies were undertaken in various parts of Turkey. The results of the experiments carried out with samples of snow and rain water indicated that by the end of 1961, the radioactivity was higher by a factor of 2 to 3 than before the start of the testing. A number of absorbers were examined to determine their suitability for the purification of contaminated water; it was found that passing the water successively through alternating layers of soil and sand, then through mixed soil + sand layers was the best method. It is recommended to instruct the general public in the preparation of these relatively simple systems. (TTT)

15755 (NP-14797) RADIOACTIVITY SURVEY DATA IN JAPAN. Number 3. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1964. 35p. Dep.(mn).

Cumulative data are presented on the content of ^{137}Cs and ^{90}Sr in samples of rain water, milk, total diet, human blood, and human urine collected in Japan from Jan. 1961 through March 1963. Analytical methods are described that were used in the analyses. (C.H.)

15756 (NP-14814) MIGRATION OF FALLOUT AND FALLOUT SIMULANTS INTO SOILS. Technical Report R-362. Type C Final Report. Alfred E. Hanna (Naval Civil Engineering Lab., Port Hueneme, Calif.). Feb. 24, 1965. 51p. $1.50(CFSTI).

A series of tests was performed to determine whether radioactive fallout would migrate vertically downward through soils. A thin layer of fused or leachable fallout simulant (Monterey sand coated with $^{140}Ba-^{140}La$) or of natural fallout (fission products in soil) was spread on trays containing frozen soil mixtures. The trays were alternately thawed and allowed to refreeze, with radiation-level measurements made periodically. After a number of thaw-freeze cycles the frozen soils were vacuumed to remove surface activity. Core samples of the soils were taken and layers of the cores were counted to determine actual migration. It was concluded that migration did occur by leaching and particle movement, and that particle migration occurred only in soils having a wide range of particle sizes. A single vacuuming removed most of the detectable activity. (auth)

15757 (TID-21521) ECOLOGY OF ACANTHARIA IN RELATION TO THE Sr CIRCULATION IN THE SEA. Progress Report, July 23, 1964–January 23, 1965. Bruno Schreiber (Parma Univ. (Italy). Istituto di Zoologia e Anatomia Comparata). Contract IAEA 62/Ren.3/US. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented on the radioactivity of samples of sea water, marine sediments, and plankton from the Ligurian and Adriatic Seas. Emphasis was placed on the radioactivity due to fallout fission products. The ability of Acantharia to concentrate ^{90}Sr was demonstrated. Data are included from a study of the ecology of Acantharia in relation to Sr circulation in the sea. (C.H.)

15758 OCEANIC LEAD ISOTOPES AND ORE GENESIS. John S. Brown. Econ. Geol., 60: 47-68(Jan.-Feb. 1965).

The data of Chow and Patterson on the isotopic composition of lead in ocean-bottom sediments were grouped and recalculated for analysis according to principles previously suggested. The resemblance between oceanic leads and the youngest normal ore leads suggested that the genesis of lead-bearing ores is a process concomitant to marine sedimentation and that the principal ore fluid is essentially connate water concentrated by diagenetic processes. Ore deposition from this fluid commonly is stimulated by heat from igneous sources, but there are notable exceptions. Ordinarily it occurs only long after the original sedimentation, but before metamorphic recrystallization. Anomalous leads of the common Joplin, or J-type, are believed to result mainly from the selective leaching and commingling of radiogenic lead from much older rocks such as a Precambrian basement beneath Paleozoic sediments. Anomalies of the so-called B-type occur when ore fluid generated in a given horizon is expelled upward to produce deposits in younger rocks. (auth)

15759 THE ISOTOPIC COMPOSITION OF LEAD IN MICROCLINES FROM THE LLANO UPLIFT, TEXAS. Robert E. Zartman (Geological Survey, Washington, D. C.). J. Geophys. Res., 70: 965-75(Feb. 15, 1965).

The isotopic composition of Pb and the concentrations of Pb and U in microclines were determined for some igneous and metamorphic rocks from the Llano Uplift, Texas. At the time of their crystallization, all the microclines from the igneous rocks had rather similar lead isotopic compositions ($^{208}Pb/^{204}Pb$ = 16.6 to 17.0, $^{207}Pb/^{204}Pb$ = 15.4 to 15.5 $^{208}Pb/^{204}Pb$ = 36.4 to 36.7), which yield model ages very close to their Rb-Sr age of 1000 to 1100 million yr. Conversely, the microclines from the Valley Spring gneiss exhibit a wide range in isotopic composition ($^{206}Pb/^{204}Pb$ = 17.1 to 19.1, $^{207}Pb/^{204}Pb$ = 15.5 to 15.7, $^{208}Pb/^{204}Pb$ = 36.8 to 38.2), which suggests a more complex history. Most of the Pb in the plutonic rocks was probably obtained from a rather uniform source, which is possibly related to some deep crustal or upper mantle layer and which also provides the reservoir of so-called "conformable" ore Pb. Some special mechanism of selective mobilization and extensive mixing would have been required if the presently exposed metamorphic host rocks contributed a significant part of the Pb to the igneous rocks. Several total rocks were analyzed, and their $^{206}Pb/^{204}Pb$ ratios were calculated as a function of time by means of the presently observed U/Pb ratio. In the analyses of an igneous and a metaigneous rock, it was found that the $^{206}Pb/^{204}Pb$ ratio in the rock became equal to that in the microcline approximately 1100 million yr ago, which suggests initial lead homogeneity and subsequent closed system conditions. The microcline and total rock from four metamorphic rocks, however, were calculated to have equal Pb isotopic compositions at times other than that reasonably attributable to some tectonic event. U and Pb migration and initial Pb inhomogeneity in these rocks are considered as possible causes of their discrepant behavior. (auth)

15760 SOME CONSIDERATIONS ON THE STUDY OF RADIOACTIVE DEBRIS AT HIGH ALTITUDE. Tatsuo Urai (National Defense Agency, Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 18-23(Jan. 1965).

Some critical examinations were made on studies reported in three previous papers. The collecting efficiency of an airborne sampler used for sampling radioactive debris at high altitude was considered to be 100%. The indication of the anemometer used for measuring air volume was volumetric and did not depend on the state of the air. Explosion dates of nuclear weapons were calculated from collected samples by the formula $A(t) = A_1 t^{-1.2}$. This formula held well when "t" was small, but samples taken more than 50 days after explosion did not yield good results. Time-dependent variations of the concentrations of radioactive debris sampled above the isles of Hokkaido, Chubu, and Kyushu districts were studied. The study revealed that a turbulent diffusion mixing process must prevail in the meridional air flow mechanism in the lower stratosphere. (auth)

15761 RADIOACTIVE FALLOUT PARTICLES. Tetsuo Mamuro (Radiation Center of Osaka Prefecture). Mizushori Gijutsu, 5: No. 2, 15-21(Feb. 1964). (In Japanese)

Since autumn 1961, large fallout particles whose diameters are larger than 10μ and with radioactivities of mμC have been detected in various parts of Japan. The separation of these particles and the studies of their physical and

chemical natures are possible for the individual particles; this gives a clue to the behavior of the usual fine fallout particles. The distribution of these highly radioactive particles deposited on a filter paper of the dust collector, a vinyl sheet, and on the leaf of a native arrowroot was investigated by autoradiography. It was found that in order to evaluate the radioactivities in rain water and in the air, the collection of a large amount of sample is necessary, because of their wide distribution. The sizes, shapes, colors and activities of these particles were observed by optical and electron microphotographies. The results are described, and are summarized in a table. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

15762 FISSION PRODUCT FALL-OUT FROM THE NUCLEAR EXPLOSIONS OF 1961 AND 1962. D. H. Peirson and R. S. Cambray (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 205: 433-40 (Jan. 30, 1965).

Based on previous fission product measurements, the physical behavior and fate of the fission debris produced during the nuclear explosions of 1961 and 1962 are reported. Tropospheric and stratospheric fission products and atmospheric mechanisms are discussed. (P.C.H.)

15763 FURTHER STUDIES OF RADIOACTIVITY LEVELS IN PERMANENT AND MIGRATORY BIRDS. M. Zanetti and F. Cutrufelli (Universita, Bologna). Nuovi Ann. Igiene Microbiol., 14: 339-41(Sept.-Oct. 1963). (In Italian)

Forty-four birds of seven species were examined for radioactivity, including woodpecker, partridge, fieldfare, blackbird, thrush, rock thrush, and woodcock. They were all captured between December, 1962, and January, 1963. Activity of K ranged from 2199 to 2790 pC/kg. Total β activity exclusive of K varied from 439 to 4886/pC/kg. Activity of ^{90}Sr ranged from 86.8 to 1746.7 pC/kg, and ^{137}Cs activity had a range of 110.1 to 734.1 pC/kg. The data do not differ greatly from those obtained during the winter of 1961–1962. Values obtained for one species permanent in Bologna show a lower range of activity than those species which are permanent in northern Europe or have their nesting zone there. (BBB)

15764 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 37, APRIL-JUNE, 1964. Tokyo, The Japan Meteorological Agency, 1964. 60p. (In English and Japanese)

Data are tabulated on: measurements of temporary standard samples (U_3O_8); mean and observed radioactivity in rain collected daily at fixed times; observed radioactivity in airborne dusts; and ^{90}Sr deposits for the period 1962 to 1963. (H.M.G.)

Techniques and Equipment

15765 (AEET/NP/11) RECENT ADVANCES IN SEISMOLOGY. H. M. Iyer. (Atomic Energy Establishment, Trombay (India)). 1964. 13p. Dep.(mn).

Some of the developments of new ideas arising out of the recent world-wide interest in seismology are discussed. The emphasis is mainly on techniques of instrumentation and fast computation, that have become possible only during the past few years. (auth)

15766 (UCRL-7855) ON THE POSSIBILITIES OF DETECTING ANTINEUTRINOS FROM NUCLEAR EXPLOSIONS. S. F. Eccles and M. H. Blue (Lawrence Radiation Lab., Univ. of California, Livermore). Aug. 21, 1964. Contract W-7405-eng-48. 38p. Dep.; $3.00(cy), 1(mn) CFSTI.

The possibility of detecting antineutrinos from an underground nuclear explosion was investigated with a thought toward measurement of the yield of the nuclear device. A secondary consideration was that of doing basic physics experiments with the large antineutrino flux available from a nuclear explosion. Three detector types were studied, all based on the following interaction of antineutrinos with matter: $\bar{\nu} + p \rightarrow \beta^+ + n$. The main assumption made for the detection was that the detector would be placed far enough from the center of the blast to withstand the shock wave, and then to count for long times (of the order of a minute) after the explosion. While background seems to pose no serious problems, the signal rate for any reasonable-sized detector is extremely low, even for moderately large explosions. Due to the inherently low counting rates expected from these detectors, and the geometry that is necessary in this type of experiment, it is concluded that none of the detectors considered would be economically feasible to either measure the yield of a nuclear device or to do basic physics experiments. Some speculations on possible different approaches to the detection of antineutrinos from nuclear explosions are made, and suggestions for further study are given. (auth)

15767 (UCRL-12219) CALCULATION OF SEISMIC SOURCE MECHANISMS. Fred Holzer (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 13, 1965. Contract W-7405-eng-48. 54p. (CONF-650107-1) Dep. (mn); $3.00(cy), 2(mn) CFSTI.

From Royal Society Meeting on Seismic Recording and Analysis, London.

A method was developed which allows computation, in the inelastic region and near the inelastic-elastic boundary, of the earth motions resulting from an underground nuclear detonation. It utilizes a one-dimensional digital computer code in which the conservation equations are transformed to difference equations in Lagrangian form. Changes of state from gas to liquid to solid are handled by switching to different equations of state as the internal energy drops below the enthalpy of vaporization and fusion, respectively. Within the solid region, inelastic processes such as plastic yielding, crushing, or cracking are handled by changing the stress deviator equations. Throughout the calculation, the time and space dependence of the shock wave parameters as well as the rate of energy deposition and material behavior behind the shock front is tied to experimentally determined properties of materials including among others the Hugoniot equations of state. Experimental confirmation of this method is most convincing in the region above 10 kbar, where peak radial stresses measured on detonations in granite, dolomite, and salt agree within 20%, with predicted values, and those for detonations in tuff and alluvium agree within 30%. Measured shock position curves from explosions in granite, tuff, and alluvium are in excellent agreement with calculations. In the lower stress region the calculation is more difficult and not quite as successful. However, substantial agreement has been obtained between calculated and experimental stress history data from detonations in granite, alluvium, tuff, dolomite, and salt. Also, the reduced displacement potential was computed both from calculated and measured displacements at 300 m from the Salmon explosion with agreement to within 25% in peak values. (auth)

15768 RADIOCARBON DATING. H. H. Green (Univ. of New South Wales, [Australia]). At. Energy Australia, 8: 10-14(Jan. 1965).

Principles of radioactive dating are reviewed. Methods of radiocarbon dating are described. Examples of radiocarbon dating in Australia are considered. (M.C.G.)

15769 ON THE INCREASED EXPLORATION DEPTH IN PROSPECTING FOR HIDDEN URANIUM DEPOSITS BY PRIMARY URANIUM OREOLES. S. V. Grigoryan. At. Energ. (USSR), 18: 52-7(Jan. 1965). (In Russian)

A method is suggested for a rational chemical analysis of uranium (determination of the transient uranium content in specimens) in hydrothermal uranium deposits. The analysis proved very effective in revealing primary uranium oreoles, which in turn led to a more efficient exploration of U deposits. (R.V.J.)

15770 DETERMINATION OF SOURCE PARAMETERS BY AMPLITUDE EQUALIZATION OF SEISMIC SURFACE WAVES. 2. RELEASE OF TECTONIC STRAIN BY UNDERGROUND NUCLEAR EXPLOSIONS AND MECHANISMS OF EARTHQUAKES. M. Nafi Toksoez, David G. Harkrider, and Ari Ben-Menahem (California Inst. of Tech., Pasadena). J. Geophys. Res., 70: 907-22(Feb. 15, 1965).

The radiation patterns of Love and Rayleigh waves from three nuclear explosions (Hardhat, Haymaker, and Shoal)

are studied to determine the nature of the asymmetry of radiation and the mechanism of Love wave generation. From a comparative study of different explosions, it is reasoned that the Love waves are generated at the source of the explosion. The source function, represented as the superimposition of an isotropic dilatational component due to the explosion and a multipolar component due to the release of tectonic strain energy, is consistent with the observed radiation patterns and the amplitude spectrums. The amount of seismic energy due to the strain release is computed. In some cases (Haymaker and Shoal) it is found that this energy may be due to the relaxation of the prestressed medium by the explosion-formed cavity. In the case of Hardhat, it is concluded that the explosion must have triggered some other strain release mechanism, such as an earthquake. The amplitude equalization method is applied to surface waves from an earthquake to determine the source parameters. From only the amplitude spectrums and radiation patterns of Love and Rayleigh waves, the source of functions, source depth, strike and dip of the fault plane, and the rake of displacement are determined for the July 20, 1964, Fallon earthquake. (auth)

15771 GEOCHEMICAL CONSTANTS FOR RUBIDIUM AND STRONTIUM IN BASIC ROCKS. Akimasa Masuda (Tokyo Univ.). Nature, 205: 555-8(Feb. 6, 1965).

A method is described for deriving initial abundances and partition coefficients for Rb and Sr in the Earth from variation of abundance of elements in silicate material. The results showed that agreement between isotopically estimated ratio and the theoretically corrected one was good. The small difference between calculated and measured (or corrected) Rb/Sr ratios may be attributed in part to an uncertainty of the $^{87}Sr/^{86}Sr$ ratio for the stage of rise of heterogeneity in the Earth. The corrected abundances of Rb and Sr for Deccan plateau basalt are 7.9 and 170 ppm, respectively. (P.C.H.)

15772 INDUCED GAMMA RAY LOGGING AT A PLURALITY OF LEVELS IN A WELL BORE. Jay Tittman (to Schlumberger Well Surveying Corp). U. S. Patent 3,156,822. Nov. 10, 1964. Filed Nov. 20, 1959.

Methods and apparatus are proposed for investigating the earth's formations transversed by a bore by bombarding with neutrons and observing the nuclear processes produced. Specifically the method is described for the determination of the relative amounts of two different materials in the earth, which, when bombarded by neutrons, produce either exactly the same radioisotope or two different radioisotopes having substantially the same half life. At some level in the bore, the formation is bombarded with relatively fast neutrons and the resulting γ activity is detected simultaneously at several distances from the level of bombardment by individually shielded γ detectors. By proper positioning of the detectors and by graphical treatment of the data obtained, the relative amounts of the two elements may be determined. The determination of Al and Si is used as an example. (A.G.W.)

Thorium and Uranium Minerals

15773 THORIUM DISTRIBUTION OVER MINERALS OF NEPHELINE SYENITES OF THE LOVOZERO MASSIF. A. I. Polyakov and G. A. Kot (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 1, 73-85(Jan. 1965). (In Russian)

Data on thorium contents of monomineral fractions of chief rock varieties of the Lovozero massif (Kola peninsula) are given. Results of microradiographic investigations and data on selective leaching are described. Thorium present in rocks of the massif, may isomorphously enter the lattices of rare-earth minerals, disseminate in rock-forming minerals, or exist in submicroscopic isolations of minerals. The amount of Th present in rocks in the two last forms may range from 8 to 90% of the total amount; it is easily leached out by a 2% solution of $(NH_4)_2C_2O_4$. Two tendencies in the behavior of Th are outlined. The chief part of the thorium is found in accessory minerals in early crystallization stages of the melt (lujavrites and urines). Thorium accumulates in the residual melts in the late postmagmatic stage in submicroscopic isolations of minerals located over the boundaries and within the grains of rock-forming minerals (foyaites, a part of eudialytic lujavrites). (auth)

15774 URANIUM AND THORIUM IN PALEOZOIC GRANITOIDS OF THE CENTRAL PART OF THE EASTERN SAYAN (INTERFLUVE OF THE MALY TAGUL AND THE UDA). N. G. Lin, L. N. Morozov, and V. P. Mironov (Inst. of Geochemistry, Irkutsk, USSR). Geokhimiya, No. 1, 86-91(Jan. 1965). (In Russian)

Uranium and thorium contents in paleozoic granitoids of the interfluve of the Maly Tagul and the Uda were found to depend on the composition of rocks, and increased with increasing free silicic acid. In the more ancient Bugulminsk intrusive complex high values of the Th/U ratios were noted; for syenites because of the low uranium content and for syenite-diorites and granites because of high thorium contents. In the younger Ognitsk intrusive complex the uranium and thorium contents regularly increased from most ancient facies to younger ones; the values of the Th/U ratios decreased in the same succession. In hybrid-rock contamination processes distorted the true geochemical history of radioactive element behavior. (auth)

15775 URANIUM AND THORIUM BEHAVIOR IN THE MAGNETIC FORMATION PROCESS OF THE MASSIF OF THE POTASSIC ALKALINE COMPLEX IN NORTH KAZAKHSTAN. A. A. Lebedev-Zinovev. Geokhimiya, No. 1, 92-6(Jan. 1965). (In Russian)

The regular increase of uranium (from 0.0005 to 0.0032%) and thorium (from 0.0013 to 0.0069%) content during the greater part of the process of multiphase massif formation was found to be chiefly conditioned by a magmatic differentiation of the principal potassic alkaline melt in the direction of nepheline basalt → phonolite, and to a lesser extent to depend on the replacement in time of volcanic process conditions by subvolcanic and then intrusive hypabyssal conditions. A decrease in uranium and thorium content was typical of the formation of intrusions of the final complex phases. The average uranium content in rocks of the massif was 0.00102%; the average thorium content 0.0031%. The shift of values of the thorium–uranium ratio in favor of uranium and their decrease in time was conditioned by a potassic specialization of the magmatic and autometamorphic formation processes of the massif. (auth)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection.

Refer also to abstracts 15214, 15300, 15343, 15351, 15697, 15706, 15732, 15733, 15754, 15942, 16466, 17188, 17249, and 17329.

15776 (AD-424694) DEBRIS CLEARANCE STUDY. Summary of Research Report. E. B. Ahlers (IIT Research Inst., Chicago, Ill.). Sept. 1963. 9p. $1.10(CFSTI).

This initial study of problems involved in clearing structural debris in cities after nuclear weapon attack was directed toward identifying the major problems involved and performing limited technical studies in several of the problem areas. Procedures were developed for estimating gross debris accumulation in various types of urban areas, based on complete structural demolition and uniform distribution of the fragmented materials. Theoretical studies on the fragmentation process were initiated toward quantifying and fragment-size distribution of demolished structural elements. Estimating tables were prepared to indicate the capacities of excavating equipment in removing debris. Major problems involved in planning and scheduling debris removal operations and the essential elements of a clearance program are described. Associated problems resulting from radioactive contamination of the rubble are discussed. (auth)

15777 (AECL-2114) THE ACQUISITION AND PROCESSING OF RADIATION EXPOSURE DATA AT THE CHALK RIVER NUCLEAR LABORATORIES. G. B. Knight and P. C. Rowe (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1964. 14p. Dep.; $1.00(AECL).

A new photobadge has been in use at CRNL since December 1962: it is capable of indicating external gamma-ray exposures and beta-ray skin doses. The radiation exposure data acquisition and processing system has been modified to report this information routinely. A detailed radiation exposure history is maintained in a Kardex file for every routinely monitored worker. Group analysis of the exposure data is handled by computer using punched cards. Group listings of the radiation exposures are distributed to Branch Heads, and each exposed worker is informed in writing. (auth)

15778 (AECL-2123) PHYSIOLOGICAL PROBLEMS OF PLASTIC PROTECTIVE CLOTHING. J. R. Brown (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1964. 28p. Dep.; $1.00(AECL).

A study was made of the physiological stresses imposed by the wearing of impermeable clothing and the effect of ventilating such clothing. Under conditions of a hot thermal environment the heat stress to the wearer, imposed by impermeable clothing, was greatly reduced by ventilation. The value of the vortex tube cooler was examined and it proved to be satisfactory in the four tests carried out. (auth)

15779 (AEET/HP/Th-2) MAXIMUM PERMISSIBLE LEVELS OF SURFACE CONTAMINATION. S. Somasundaram, P. V. Hariharan, and A. K. Ganguly (Atomic Energy Establishment, Trombay (India)). 1964. 18p. Dep.(mn).

Ingestion, rather than inhalation, constitutes the greatest hazard for radioactive contamination of persons working in laboratories in India. Comparative data are reviewed on maximum permissible levels of contamination for surface areas, hands, skin, clothing, and shoes. Maximum permissible levels of contamination are presented for laboratories in India. (C.H.)

15780 (CEA-R-2558) ETUDE GRANULOMETRIQUE DES PARTICULES D'OXYDE DE PLUTONIUM EN SUSPENSION DANS L'ATMOSPHERE D'UNE ENCEINTE DE FONDERIE PENDANT LA FABRICATION D'ALLIAGES U–Pu. (Granulometric Study of Plutonium Oxide Particles in Suspension in the Atmosphere of a Furnace Enclosure During the Preparation of U–Pu Alloys). Georges Bataller and Siegfried Lenkauer (Commissariat à l'Énergie Atomique, Cadarache (France). Centre d'Études Nucléaires). 1964. 48p. Dep.(mn).

Since the extent of an internal contamination by respiration depends on the diameter of the radioactive particles in the atmosphere, a particle size study has been made of the particles present in the air of a working enclosure at the Plutonium Fuel Element Production Section during the preparation of uranium-plutonium alloy bars. The air of this vessel is drawn through a glass fiber filter on which the dust is deposited. On these filters, the radioactive particles are localized first of all by the luminous spots which they produce on a photographic plate when a scintillator is interposed (silver-activated zinc sulphide). An autoradiographic method then makes it possible to distinguish between, and to measure the particles of the oxides of uranium-235, uranium-238, and plutonium-239. On carrying out a microscopic scanning of the relevant parts of the filter, particles are seen surrounded by radial marks the length of which indicates the nature of the grains, and the number of which makes it possible to calculate the theoretical diameter of the radioactive grain. This latter can be compared with the diameter observed with the microscope. Thus for each category of particles it is possible to define a mean diameter and therefore to predict the path of the various inhaled particles in the human body. These results are compared with the very few weakly positive biological samples taken from the personnel working in this enclosure. (auth)

15781 (EUR-2113.f) L'ETUDE DES ATTITUDES PSYCHOLOGIQUES DES TRAVAILLEURS NUCLEAIRES VIS-A-VIS DU RISQUE RADIOACTIF. (Study of Psychological Attitudes of Nuclear Workers Towards Radioactivity Risk). P. Sivadon and A. Fernandez (Centre de Recherches Psychopathologiques, Paris (France)). 1964. 8p. Dep. (mn).

Factors affecting the psychological attitudes of personnel in nuclear industries toward radiation exposure risks are discussed. Several methods of approach are called for in a study of such attitudes. These include analysis of personal histories and medico-psychological clinical examination; analysis of responses to certain psychometric tests and personality projection tests; objective analysis of psychological aspects connected with the job; collective approach and study of the dynamics of the working parties and circles in which the worker moves. The final psychological attitudes are complex and have a shifting history. Knowledge of them will be of the utmost value in improving adaptation to radioactive hazard and obtaining the right responses to the ups and downs of individual and collective safety conditions. (C.H.)

15782 (EUR-2213.e) ENVIRONMENTAL RADIOACTIVITY, ISPRA 1963. M. de Bortoli, P. Gaglione, A. Malvicini, and E. Van Der Stricht (European Atomic Energy Community, Ispra (Italy)). Joint Nuclear Research Center. 1965. 68p. Dep.(mn)

Results are reported from measurements of environmental radioactivity performed during 1963 at the Ispra Establishment, Italy. Data are given on the concentrations of strontium-90, cesium-137, and other radionuclides in fallout, air, water, herbage, animal bones, and foods. (C.H.)

15783 (GAT-450) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, 1964 SECOND HALF AND ANNUAL SUMMARY. B. Kalmon (Goodyear Atomic Corp., Piketon, Ohio). Mar. 1, 1965. Contract AT(33-2)-1. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Average environmental radiation levels and concentrations in the vicinity of the Portsmouth Area Gaseous Diffusion Plant were compiled for the months of July through December, 1964, and for the calendar year 1964. These

levels and concentrations are summarized. During 1964, the average annual concentrations for both alpha and beta-gamma activity in the neighboring streams, creeks, and river were significantly below those of 1963. Alpha and beta-gamma activity was characterized by respective decreases from 0.12 to 0.07 percent and from 0.19 to 0.07 percent of the maximum permissible concentrations (MPC). Averages computed on a semi-annual basis were also markedly (and uniformly) below the 1963 annual averages. On an average annual basis, airborne alpha activity during 1964 was essentially the same as that of 1963 while average airborne beta-gamma activity sharply declined. Alpha and beta-gamma activity was 5.0 and 0.15 percent MPC compared to the 1963 levels of 5.0 and 0.78 percent, respectively. For the first versus the second half of 1964, average alpha levels increased from 5.0 to 5.5 percent MPC while beta-gamma levels decreased from 0.23 to 0.08 percent MPC. Decreases in annual average background exposure rates were evident as the average fell to 47 percent from the 1963 average of 63 percent maximum permissible exposure (MPE). The average background exposure rates for both halves of 1964 were identical (each 47 percent MPE). In calculating the percentages, all activity was assumed to result from plant operations. However, it was found that the patterns, off-site and on-site, are remarkably similar with no appreciable difference between the averages. Therefore, on-site as well as off-site background exposure rates are due to natural radiation and fall-out from past nuclear tests. (auth)

15784 (HW-83614) PROGRESS IN STUDIES OF RADIONUCLIDES IN COLUMBIA RIVER SEDIMENTS. A Summary of Hanford Achievements in This Program Under General Electric, 1963–1964. J. L. Nelson, R. W. Perkins, and J. M. Nielsen (Hanford Atomic Products Operation, Richland, Wash.). Dec. 1964. Contract AT(45-1)-1350. 26p. Dep.; $2.00(cy), 1(mn) CFSTI.

Observations on the interaction of the Columbia River radionuclides and sediments have provided considerable information on the behavior of these materials. A limited survey of the river bottom sediment inventory and a study of its radionuclide composition suggests that the main radionuclide deposits are in the McNary Reservoir and in the estuary. A study of the radionuclide concentrations and particularly of radionuclide ratios such as ^{65}Zn to ^{51}Cr in suspended and deposited sediments has clearly shown that a large amount of the Columbia River sediments with their associated radioactivity are scoured from the river bottom during the spring freshet. The magnitude of this sediment scouring action and the location of final deposition are being studied. The tracing of the scoured material by means of its associated radioactivity will answer not only the question of its final deposition but is expected to shed light on the movement and deposition of sediments in the Columbia River shipping channels which at present require almost continuous dredging to keep them open. Fractionation of the river bottom sediments into particle size groups has shown a maximum in radioactivity associated with both the smallest and largest particle sizes. This anomaly is due to the presence of larger amounts of high specific activity organic material in the coarse fractions. A clean separation of the organic material from inorganic sediments without some leaching of the inorganic material has not been accomplished; however, the studies have shown that the organic material in the sediments contains a substantial portion of the radioactivity and must certainly be considered in studying the sorption-release mechanism of Columbia River radionuclides. The physical and chemical forms of the more abundant long-lived radionuclides were investigated during the spring freshet at sampling locations between the reactors and Vancouver. A large fraction of the observed ^{65}Zn, ^{54}Mn, and ^{46}Sc from sampling stations below McNary Dam was associated with particulate material which had presumably been scoured from the McNary Reservoir. Only a small fraction of the total amount of these radionuclides which were carried by the river was in true solution. (auth)

15785 (LADC-5923) EVALUATION OF PARTICLE SIZING AND AEROSOL SAMPLING TECHNIQUES. Harry J. Ettinger (Los Alamos Scientific Lab., Univ. of California, N. Mex.) and Samuel Posner (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). [nd]. Contract W-7405-eng-36. 31p. (CONF-496-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From the American Industrial Hygiene Association Meeting, Philadelphia, Apr. 1964.

Because of increased interest in the physiological and toxicological effects caused by inhalation of various aerosols, and the dependence of these effects on aerosol particle size, a cooperative study was carried out to compare particle sizing results obtained by several laboratories throughout the country. This included the evaluation of various air samplers to determine if each sampler would define similar aerosol characteristics when sampling the same aerosol. To provide base line information, Phase I required all participating groups to size a standard aerosol where all particles were distinct and individually numbered. The several groups sizing this standard aerosol agreed within ±10% in defining count median diameter and geometric standard deviation. In Phase II, a uranium oxide aerosol was collected and sized to introduce and evaluate the variables present when dealing with a real aerosol having agglomerates. In this case, count median diameters and geometric standard deviations obtained by the participating laboratories agreed within ±10%. In Phase III, an aerosol was generated and collected using several different air samplers. Count median diameters agreed within the ±10% variation noted in Phases I and II. Greater variations were present in geometric standard deviation producing differences up to a factor of 6.7 in mass median diameter. (auth)

15786 (NP-14627) CONTRIBUICAO AO ESTUDO DO ESTRONCIO ^{90}EM MATERIAIS BIOLOGICOS (TESE). (Contribution to the Study of ^{90}Sr in Biological Materials (thesis). Elias Mansur Netto (Minas Gerais Univ., Belo Horizonte (Brazil)). [1962]. 83p. Dep.(mn).

The content of ^{90}Sr in milk in the State of Minas Gerais in Brazil is reported for 1960 and 1961. The sampling and the analytical methods used are described. The results obtained are compared with the ^{90}Sr contents reported in milk samples in other parts of the world. (J.S.R.)

15787 (NP-14773) THE EFFECTIVENESS OF RADIOLOGICAL COUNTERMEASURES IN ACCELERATING POSTATTACK RECOVERY. Research Memorandum RM-OU-156-5. Joseph D. Douglass, Jr. (Research Triangle Inst., Durham, N. C.). May 29, 1964. Contract OCD-OS-64-56. 56p.

The extent to which radiological countermeasures could accelerate the postattack recovery process was evaluated. The recovery of a facility is specified in terms of the duration of the activity, the time when the activity is to commence, the allowable dose received by the activity personnel, the fallout field characteristics, and the effect of the countermeasure on these field characteristics. The acceleration of the recovery is specified by the difference between the time when the activity may commence if the countermeasure is not employed and the time when the activity may commence if the countermeasure is employed. This difference, the time saved, is analyzed as a function of the other parameters. The analysis is examined in a general manner to determine the range of situations where countermeasures appear to be potentially most valuable. (auth)

15788 (NP-14835) POSTATTACK SANITATION WASTE DISPOSAL, PEST AND VECTOR CONTROL REQUIREMENTS AND PROCEDURES. (Engineering-Science, Inc., Arcadia, Calif.). Feb. 1965. Contract OCD-PS-64-9. 129p.

In the event of a nuclear attack on the United States, environmental disease control measures will be interrupted with the surviving population exposed to the ensuing disease hazards. The probability of the occurrence of some 14 diseases that might develop is considered and the effective-

ness of available control measures and the total operational requirement for recovery of environmental sanitation in terms of manpower, equipment, and material are evaluated. The enteric infections (Shigellosis, Infectious Hepatitis, Salmonellosis, Typhoid, and Amoebiasis), especially Shigellosis (bacillary dysentery), are assigned a leading role among the diseases to be controlled, thus indicating a compelling need for the prompt removal and sanitary disposal of human feces and of spoiled food and other decomposable fly breeding potential organic material. Pending the establishment of sanitary disposal of organic wastes, the control of houseflies by adulticiding is indicated when climatic conditions favor fly production. The hazard of mosquito-borne encephalitis in those parts of the United States where encephalitis is endemic necessitates early postattack operations, as climatic conditions dictate, to rid the areas of adult mosquitoes by adulticiding with larvicidal treatment to follow. Diseases of secondary concern are Rabies, Murine Typhus, Plague, Leptospirosis, Rocky Mountain Spotted Fever, Dengue, Malaria and Yellow Fever. The endemicity of these diseases is related to the geographical location and climatic as well as the sanitary condition with timing and extent of control related to these factors. The control of the domestic rodents in the United States west of the 100° Meridian to reduce the hazard of Plague and control in the Southeastern United States and Southern California to reduce the hazard of Murine Typhus is indicated where a condition of structural damage and fallout results in sheltering for an appreciable period of time. Significantly effective control of these disease hazards in the postattack environment is possible through the utilization of material and equipment properly positioned for prompt postattack operations. The magnitude of these needs (material, equipment, and manpower) is developed for an estimated metropolitan population of 88 million. (auth)

15789 (ORNL-TM-1067) EMERGENCY ENVIRONMENTAL CONTROL SYSTEM FOR THE TUNNEL GRID SHELTER. C. D. Scott and J. M. Holmes (Oak Ridge National Lab., Tenn.). Jan. 18, 1965. Contract W-7405-eng-26. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An emergency environmental control system for shelters in the ORNL tunnel grid concept which includes means for oxygen makeup and CO_2 removal was investigated. An emergency situation was defined as a period when segments of the shelter tunnel are completely isolated from the immediate outside environment for a maximum of 8 hours. For an 8-ft-diam shelter tunnel organized into 500-ft-long, self-sustaining segments, the best environmental control system was found to be stored, high-pressure, gaseous oxygen for oxygen makeup and pelleted LiOH in cannisters associated with hand-driven blowers for CO_2 removal. At a population of 1000 persons per 500-ft section of shelter, the unit costs of this system are $5.50 per person for oxygen supply and $2.31 per person for CO_2 removal. (auth)

15790 (SC-R-64-1366) HEAT TRANSFER IN LIQUID HYDROCARBON FUEL FIRES. B. E. Bader (Sandia Corp., Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 45p. (CONF-641201-14). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From American Institute of Chemical Engineers Annual Meeting, Boston.

In recent years there has been an increased interest in the behavior of items or systems exposed to fires resulting from accidents. Included among these are shipping containers for radioactive materials. The response of an item to a fire environment is a function of the design of the item, the physical condition of the item after the accident, its position relative to the fire, and the fire environment itself. Presented are a description of the fire environment, the development of an analytical fire model, and a method used successfully to simulate fire environments. In addition, comparisons between computed and experimentally determined data are made. (auth)

15791 (SC-RR-64-562) INDUSTRIAL HYGIENE HANDBOOK. R. J. Everett, L. W. Brewer, G. W. Edwards, A. Juskiewicz, T. A. Linn, Jr., R. O. Mills, and A. J. Jack (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 153p. Dep.; $5.00(cy), 3(mn) CFSTI.

Occupational health hazards may be classified as chemical and physical. This handbook covers procedures, devices, and equipment for controlling possible occupational hazards at Sandia Corporation. (auth)

15792 STUDIES ON THE PRESENCE OF MANGANESE-54 IN A DRINKING-WATER RESERVOIR. K. Haberer and H. Bernhardt (Technische Hochschule, Karlsruhe, Ger. and Laboratorium des Wahnbachtalsperrenverbandes, Siegburg, Ger.). Atompraxis, 11: 27-33(Jan. 1965). (In German)

Gamma-spectrometric studies of water samples from the Wahnbachtal reservoir in the fall of 1963 showed relatively high concentrations of ^{54}Mn in samples taken from the deepest point. The concentration decreased rapidly in samples taken from shallower parts. Studies were made in order to explain the cause and extent of this phenomenon, which can be traced back to a selective reductive dissolution of inactive and active manganese in the sediment of the reservoir bed, the active manganese coming from radioactive fallout. (auth)

15793 TRANSPORT OF IRRADIATED FISSIONABLE MATERIAL. J. Asyee. Atoomenergie Haar Toepassingen, 6: No. 11, 255-61(Nov. 1964). (In Dutch)

The transport and storage of radioactive and fissionable materials is a necessary adjacent to the processing of irradiated fuels. The problems with respect to transport in Europe are discussed; it is expected that by 1968 or 1969 about 200 mC of activity per year must be transported. In addition to a presentation of the regulations on the transport of fissionable materials, the development of containers and transport costs are also considered. (tr-auth)

15794 MEASUREMENTS OF RADIOACTIVITY IN PERU. Alberto A. Giesecke M. (Instituto Geofisico, Peru). Bol. Junta Control Energia At. (Peru), 9: No. 49, 43-52 (Apr.-June 1964). (In Spanish)

There are two systems and programs for the measurement of radioactivity in Peru: the first is the direct measurement of virgin soil, the second is the measurement of radioactive dusts in the atmosphere and in fallout. The operation of each system is described. The radioactivity measurements are based on the measurement of the total γ rays of a given sample. The results obtained in the vicinity of Lima from April 1958 to April 1964 are shown graphically. The concept of permissible levels or radiation is briefly discussed. (J.S.R.)

15795 RADIOACTIVITY IN SOILS, WATERS, AND PLANTS IN THE AREA OF LIMA. Ignacio Frisancho P. Bol. Junta Control Energia At. (Peru), 9: No. 49, 67-76 (Apr.-June 1964). (In Spanish)

In 1964 the measurement of radioactivity in the air, water, soil, and vegetables in the vicinity of Lima was undertaken on a continuing basis. The procedures of sampling and sample preparation and the radiation detection instruments used are described. The results obtained at three sites are given for Feb., Mar., and Apr. (J.S.R.)

15796 RADIOLOGICAL PROTECTION SERVICE. Brit. Med. J., 2: 1151-2(Nov. 7, 1964).

The functions of the Radiological Protection Service, located at Sutton, England and founded jointly by the Medical Research Council and the Ministry of Health in 1953, are discussed. (TCO)

15797 RAINFALL AND MONSTERS. Brian Lees. Clin. Med., 71: 17-18(Jan. 1964).

In view of the fact that atmospheric levels of radioactive dust, ground contamination, and the amount of radioactive material in the diet have increased several fold in the past three yrs, it is suggested that there may be some correlation between this radioactivity and the incidence of physical deformities in infants born recently. A brief review was made of several pertinent reports. Most reports have concerned the possible implication of drugs in the production of congenital abnormalities. Interest in the association between drug administration during pregnancy and congenitally deformed infants led to a study in the Canadian province of

Alberta. Vital statistics showed that physical abnormalities discovered at birth increased from 7.9 per 1000 births in 1959 to 13.8 per 1000 in 1961. When all drugs taken during pregnancy by the mothers of deformed infants were tabulated, no relation could be demonstrated between use of drugs and congenital anomalies. This negative finding included anti-emetic preparations and tranquilizers, which have recently come under suspicion. In considering other possible factors, the rainfall pattern in different parts of the Province was reviewed. This showed a significant relation. In the Northern area, with high precipitation, the incidence of congenital abnormalities in 1961 was 15.5 per 1000. In southern Alberta, with lower precipitation, the incidence was found to be 11.9 per 1000. As an explanation of this finding, it was pointed out that atmospheric levels of radioactive dust containing ^{90}Sr, ^{137}Cs, and ^{140}Ce have all increased since the Soviet thermonuclear Arctic explosions took place. Rainfall washed some of this dust out of the atmosphere, leading to ground contamination and to increased ingestion of radioactive material in the diet. It is suggested that this may be the teratogenic agent. It is anticipated that there may be confirmation of this hypothesis when figures are fully available for infants born during 1962. (TCO)

15798 STUDIES ON THE RADIOACTIVE AIR POLLUTION. Erzsebet Bakacsne Polgar and Tibor Bakacs. Egeszsegtudomany, 8: 186-90(1964). (In Hungarian)

The origin of artificial radioactive air pollution was studied. The importance of continuous investigations in this field in respect of the environmental radioactivity is emphasized. The method of determination of the atmospheric radioactivity is described. In samples collected on the top of the building of the State Institute of Hygiene, Budapest, the daily and monthly averages of the activity due to artificial splitting products and the total β activity of the rainfall were studied. The monthly average of the air activities fluctuated from 0.7 to 0.9 pC/m^2. The highest activities of both the atmosphere and the atmospheric precipitation were observed in April, in conformance with the general experience that the activity due to fallout has a vernal peak. The atmospheric radioactivity has considerably declined since nuclear-weapon experiments were stopped. Finally, the literature of the so-called hot particles of $\leq 10^{-10}$ C activity, which have been demonstrated in the atmosphere most recently, are reviewed. (auth)

15799 GRAPHIC STATISTICAL ANALYSIS APPLIED TO INVESTIGATION ON RADIOACTIVITY OF SOME SURFACE WATERS IN POLAND. Ryszard Szepke (Centralne Laboratorium Ochrony Radiologicznej, Warsaw). Ekol. Polska, Ser. B, 11: 83-9(1965). (In Polish)

A graphic statistical analysis is presented as applied to the radioactivity data of some surface waters obtained during the period from 1958 to 1962. It was found that the mean contamination of the Vistula in the Warsaw district was over twice as high during the periods of nuclear weapon testing as compared with the period of atomic calm. Statistically significant differences were found between the natural contamination of the Odra and Vistula rivers, but the differences between the Vistula, Bug, Narew, and Swider rivers proved to be non-significant. Radioactivity decontamination capacity determined for the Warsaw Filtration Plant proved to be very poor, the decontamination coefficient being only 1.40. Examples are given that demonstrate the practical superiority of graphic statistical analysis over numerical methods. (auth)

15800 LOCAL ACCUMULATIONS OF FISSION PRODUCTS FROM RADIOACTIVE FALLOUT IN MOUNTAIN REGIONS. T. Dimchev and L. Manolov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 101-13(1964). (In Russian)

The results of research concerning a relatively unknown phenomenon on the accumulation of radioactive isotopes (fission products) in different localities in mountain regions are summarized. Based on measurements of gamma background, carried out in several parts of the Balkan Mountains, Rila, Pirin, and Vitosha, the existence of hot spots was disclosed, showing values of the radioactive background up to micro-Röentgen hour and surpassing many times the mean values characteristic of these regions. The observations show that these are anomalies of the radioactive background of the terrain in question, which are not due to an increased content of natural radioactive substance in the soil or at greater depth. A level of 0.95×10^{-10} to 0.94×10^{-9} C/g soil for the total beta activity of the soil was established. As the data for the activity deposited during the period of nuclear tests (from 1956 up till now) cannot account for the high values of the local concentrations of fission products (reaching in some places values larger than twice the calculated total value from precipitations and fallout), the results of an investigation on samples of old snow from snow deposits in Vitosha, Rila, and Pirin, collected during the summer months of 1961–1963 are presented. The specific beta activity of the 2 cm deep surface layer of old snow varies from 0.87×10^{-11} C/cm^3. The specific beta activity of 8 samples was 3.85×10^{-11} C/cm^3. The specific beta activity of samples from the inner layers of old snow was on the average 62 times lower. Samples of surface water discharging from below the snow were also examined. Gamma spectrometric and radiochemical analysis proved the presence of longlived fission products – ^{137}Cs, ^{90}Sr, ^{90}Y, ^{144}Ce, and $^{106}Ru + ^{106}Rh$. Based on these measurements the value of the ratio $^{144}Ce/^{137}Cs$ was obtained. Decay-curves of the beta activity from residues of snow samples taken from different layers of snow are presented. It was concluded that a relatively high activity is deposited additionally on the surface of old snow deposits as a result of global contamination. Conclusions were also drawn concerning the age of the fission products and their identification, deposited on the surface of different snow deposits and at different depths. All the numerous factors that might possibly cause these local accumulations in mountains are discussed. (P.C.H.)

15801 THE PHYSICIAN AND NATIONAL HEALTH. Mathilda R. Vaschak (Squibb and Sons, New Brunswick, N. J.). J. Am. Med. Women's Assoc., 19: 290-4(Apr. 1964).

Public health aspects of hazards from increased sources of ionizing radiation in the environment, and air and water pollution, are considered. Radiation in the biosphere may also come from such natural sources as cosmic rays and natural body sources. There are medical radiation sources: x-ray, fluoroscopy, and the use of diagnostic and therapeutic radioisotopes. Third are the industrial sources: reactors, manufacturing of radioisotopes, and laboratory research. Fourth is fallout from nuclear weapons. Although little can be done about natural sources, for example, the very high natural radiation areas in the vicinity of U mines of Utah, it is possible to do something about medical sources of radioactivity. Excessive radiation due to unsafe equipment can be controlled by an inspection program. Education and careful technique can also cut down exposure by limiting the size of the area being examined, protecting the gonads, using fast films and fast screens, properly filtering the beams, holding fluoroscopy to the minimum, and calibrating the machines annually. While presenting hazards, use of x ray and radioisotopes has contributed to better health and longevity. Industrial radiation is at present a minor problem. Fallout as a source of nuclides is discussed. After testing nuclear weapons, radiation is found in air, water, food, and milk. If a weapon is tested at low altitudes radioactive particles fall out quickly; if it is tested at higher altitudes, the particles can travel for a long time and very gradually fall to the ground. In 1961 an abnormal amount of radioiodine ^{131}I was found in the atmosphere, water, and milk. The concentration in air and water did not constitute a problem due to dilution effects. Iodine-131 has an affinity for the thyroid when ingested, and one-tenth is picked up by breathing or by drinking water. Milk, which must be collected and delivered to the consumer within a few days, poses a major problem because the half-life of ^{131}I is 8 days. Almost all other foods have a long processing time between harvest and consumption; hence contain little ^{131}I. Fallout radiation, therefore, affects children who drink milk. The possible genetic effects of radiation are briefly discussed. (BBB)

15802 COMPARISON OF A LINEAR PROGRAM IN RADIATION PROTECTION WITH A TRADITIONAL LEC-

TURE PRESENTATION. S. Thomas Elder, George R. Meckstroth, Charles M. Nice, and Phillip H. Meyers (Louisiana State Univ., New Orleans). J. Med. Educ. 39: 1078-82(Dec. 1964).

Two experiments were carried out to test the effectiveness of a program entitled "Radiation Protection: A Programmed Introduction." Statistical treatment of achievement test scores showed the programmed test to be equally as effective as lecture presentation of the same material when applied to advanced medical students. The program was designed for use with advanced medical students and residents in radiology. Preliminary tests of the program had been carried out using residents and medical students, and a class of 36 juniors at the Tulane University School of Medicine was selected as the experimental sample. These students were in the process of completing the regularly assigned radiology course. The study was made at a time when a lecture on radiation protection had been previously scheduled. The 36 subjects were assigned to one of three groups: Group A subjects were designated as controls to whom the regularly scheduled lecture presentation of the material was given. Group B subjects received the same material in the form of a linear programmed text. Group C subjects were presented the same linear program as Group B, except that Graflex Koncept-O-Graph teaching machines were used to present the program. An achievement test was administered to all students at the end of the period, and a different but comparable test was administered one week later in order to discover possible retention differences. Analysis of percent frequency of error responses per program frame suggests some modification of the program may enhance its adequacy as an educational device. (BBB)

15803 EMERGENCY MEDICAL TREATMENT UNIT. PHASE I. Med. Bull. U. S. Army, Europe, 18: 195-7(Oct. 1961).

The medical treatment of mass casualties resulting from a thermonuclear explosion is considered. An outline is given of some problems in the treatment of mass casualties. (TCO)

15804 RADIOACTIVITY MEASUREMENTS IN AUSTRIA. Third Annual Report. Mitt. Oesterr. Sanitaetsverwaltung, 64: 298-338(1963). (In German)

Results of measurements on the environmental radioactivity and the radioactivity of foods made in Austria in 1962 are reported. The sampling network and measurement methods are briefly described. The long-lived beta activity near the ground, in the higher air layers, on dust particles, and from fallout was determined, and the results are tabulated. The β activity of surface and ground waters and drinking water was also determined. The radioactivity of the food consumed in 1962 was surveyed and the mean ^{90}Sr content was calculated. (J.S.R.)

15805 THE STRONTIUM-90 ACTIVITY IN MILK 1963. H. Seidler and M. Haertig (Institut fur Ernahrung, Deutsche Akademie der Wissenschaften, Potsdam, Ger.). Nahrung, 8: 555-8(1964). (In German)

Strontium-90 activities in milk samples were compared with the amount of rainfall and the beta activities in the air and in fall-out in the Potsdam area for 1963. The annual mean of the strontium-90 activity of milk was 9.1 SU, beta activity in the air 4.9 pC/m^3, and beta activity in fall-out 4.7 nC/m^2. (auth)

15806 RECENT TRENDS IN THE LEVEL OF FALL-OUT CAESIUM-137 IN MAN. S. H. Cohn, E. A. Gusmano, and R. A. Love (Brookhaven National Lab., Upton, N. Y.). Nature, 205: 537-9(Feb. 6, 1965). (BNL-8487)

The content of ^{137}Cs from fallout in man was investigated in 10 adults for the period June 1960-Sept. 1964. A 30 min count was obtained from each subject at monthly intervals for the 4-year period. A continuous fall in ^{137}Cs levels was found from June 1960 until the spring of 1962. However the ^{137}Cs levels continued to rise to August 1964. The mean ^{137}Cs level in August was 180 pC/g K, which corresponds to a dose rate of 3 mR/y, or 2.2% of that from natural radiation sources. The values of the most recent measurements in mid-Sept. 1964 were lower in each subject than those recorded in August. The small population examined reflects the level of ^{137}Cs found in a large changing Brookhaven population counted during the same period. Also, the mean ^{137}Cs level of the larger Brookhaven population sampled was very close to the mean of a still larger U. S. and Western European population. (P.C.H.)

15807 CHARACTERISTICS OF DOSIMETER FILMS PROCESSED IN PHENIDONE-THIOSULFATE MONOBATHS. Margarete Ehrlich (National Bureau of Standards, Washington, D. C.). Photo. Sci. Eng., 9: 1-9(Jan.-Feb. 1965).

Characteristics of 3 types of commercial x-ray dosimetry films exposed to x and gamma radiation of widely different photon energies were compared for processing in Phenidone–thiosulfate monobaths and in x-ray and Phenidone developers. Monobath processing had a number of advantages for routine dosimetry applications. There was little dependence of response on processing time and temperature and, because of lower contrast, the useful exposure range was extended. But difficulties due to rate dependence were more likely, and film sensitivity was reduced. One of the main features of the sensitometric behavior and the grain structure obtained with monobath processing was the interplay of the characteristics of physical development, prevailing at low density levels, and those of chemical development at high densities. In contrast to their appearance for conventional development, the silver aggregates corresponding to fog produced by the monobath and the aggregates corresponding to relatively low densities above fog were large, smooth, and compact. The corresponding photometric equivalent was high. For higher exposures and densities, the differences in photometric equivalent and in the structure of the image silver for conventional and monobath processing tended to disappear. This pointed toward a change in the predominant development mechanism with density level. (auth)

15808 MEASUREMENTS OF RADIOACTIVITY ON COMMERCIAL AIRPLANES. R. Laplane, J. Bernard, and E. Lafontaine (Direction du Materiel, Air France, Paris). Rev. Med. Aeronaut., 2: 419-21(Aug.-Sept. 1963). (In French)

Beginning in December 1961, a series of measurements was carried out regularly on the planes of Air France. Rapid measurements with a Geiger counter or radiometer were taken routinely four or five times a week on two particular aircraft regardless of their flight and on the planes travelling the polar route from Tokyo. Two Boeing jets had devices installed within the engine exchanger tunnels for radioanalysis of dust; one had a detector-recorder for gamma radiation in the baggage compartment. Uniform results were obtained from numerous measurements. All recorded values except five were below 0.5 mR/hr, with a mean equal to about 0.3 mR/hr. The five high values were between 2 and 0.75 mR/hr. Values were compared to those found in water, grain, and milk. It was concluded that radioactivity levels on commercial aircraft does constitute a danger to public health. (TCO)

15809 CONTROL SYSTEMS FOR NUCLEAR MATERIALS: THE U.S.A. STANDARDS FOR SPECIAL FISSILE MATERIALS. Enrico Santarelli. Riv. Ing. Nucl., 2: 527-30(Sept.-Oct. 1964). (In Italian)

The control of fissile materials in the United States lies with the A.E.C., which licenses its use by private industry. The primary concern of the licensing regulations is safety against ionizing radiations and nuclear safety. The procedures and information that must be provided by the licensee in order to procure a license are indicated. (J.S.R.)

15810 RADIOLOGICAL DEFENSE IN TEXAS. Charles E. Barden (State Dept. of Health, Austin, Tex.). Texas State J. Med., 60: 31-3(Jan. 1964).

Civil defense in Texas is organized under the Radiological Defense Program (RADEF), which is concerned with increasing the survival rate after a nuclear attack. The mission of RADEF in Texas is: to plan and direct actions that can be taken to decrease the number and degree of radiation casualties; to reduce or eliminate the harmful effects of radiation contamination and exposure after survival; and

to reduce or eliminate contamination in later periods of local and national rehabilitation. The organization has established these statewide capability objectives: to organize, train, equip, and direct a force capable of using effective measures against radiation hazards created by nuclear explosions; to predict areas of fallout with corresponding fallout zone radiation levels, and to inform the people within each area of existing dangers and how they can best protect themselves; to monitor areas to determine radioactive contamination; and to establish ways to protect food and water, and to decontaminate and dispose of radioactive materials. Local leadership and participation are involved in the 17 radiological defense districts that have been established, with a RADEF officer in each district. The radiological defense operational set, which is used for both public shelter and outlying monitoring stations, includes several detection instruments. One Geiger counter with earphones to detect low-level contamination of food, water, and personnel. Its range is 0 to 50 mR/hr. One ionization chamber survey meter for detection of high-range radiation, at intensities from (500R/hr. To measure the total dosage received by monitoring personnel, the set includes three pocket chambers (direct reading dosimeters), which have a range of 0 to 200 R. There is also a charger to reset the dosimeter after each use. (TCO)

15811 OBJECTIVES AND POSSIBILITIES OF RADIOPROTECTION. J. Kuehboeck (II Medizinische Universitatsklinik, Vienna). Wien, Z. Inn. Med. Grenzg., 44: 513-19 (Dec. 1963). (In German)

Medical radioprotection has become an important phase of modern industrial medicine. Along with technical protective measures, medical supervision in industries that use radiation must be concerned necessarily with appropriate personnel selection and above all with the prevention and early discovery of chronic radiation injuries. For this purpose morphological studies of blood and bone marrow are still the most sensitive method of procedure. The development of radiation protection substances and preparations to promote the excretion of radionuclides remains very unsatisfactory. Next to Zr preparations, compounds that form chelates appear to have definite promise as therapeutic agents for certain radioelements. However, the excretion of radiostrontium, which because of its long half value time and affinity for the skeleton is especially dangerous, represents a difficult therapeutic problem that still is unsolved. (BBB)

15812 ENVIRONMENTAL CHANGE AND RESULTING IMPACTS ON HEALTH. REPORT OF A WHO EXPERT COMMITTEE. World Health Organ., Tech. Rept. Ser., No. 292, 1-23(1964).

Health problems connected with radiation, air pollution, liquid and solid wastes, food hygiene, and other manifestations of environmental change in modern life are reviewed. Special attention is given to the increase in sources of radiation, air pollution, and the great rise in the volume of wastes requiring new and more effective methods of disposal. It was concluded that the future should be viewed with modified optimism rather than with alarm: the danger constituted by radiation, for example, is very limited in terms either of the population at risk or of the area involved. It is recommended that high priority be given in health control programs to food hygiene, the provision of safe drinking water, and the proper treatment of wastes, in the light of the character and financial resources of each individual country. (P.C.H.)

15813 STRAHLENSCHUTZ IN FORSCHUNG UND PRAXIS. BAND 2. (Radiation Protection in Research and Practice. Volume 2). Freiburg i. B., Verlag Rombach and Co., 1963. 374p.

The papers presented at the Second Advanced Study Conference of the Association of German Health Physicists and the discussions are compiled. The topics discussed are fundamental principles of biophysics and radiobiology, chronological radiation burden of man, the effect of chemical substances in radiation injury, practical radiation protection in medicine, radiation protection in technology and industry, and psychological problems in radiation protection. (J.S.R.)

15814 STRAHLENSCHUTZ IN FORSCHUNG UND PRAXIS. BAND 3. (Radiation Protection in Research and Practice. Volume III). Freiburg i. B., Verlag Rombach and Co., 1963. 331p.

The papers presented at the Third Advanced Study Conference of the Association of German Health Physicists and the discussions are compiled. The topics discussed are natural and artificial radioactive materials in research and practice, radiation risks in the use of radioactive materials, accidents in the handling of radioactive materials and the treatment possibilities, radioactivity in the human environment, and the radiation burden of the population. (J.S.R.)

15815 STRAHLENSCHUTZ IN FORSCHUNG UND PRAXIS. BAND 4. (Radiation Protection in Research and Practice. Volume IV). Freiburg i. B., Verlag Rombach and Co., 1964. 380p.

The papers presented at the Fourth Advanced Study Conference of the Association of German Health Physicists and the discussions are compiled. The topics discussed are diagnosis of radiation injury and injuries resulting from radiation combined with other causes. (J.S.R.)

15816 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG. BERICHT III/64. (Environmental Radioactivity and Radiation Burden. Third Quarterly Report, 64). Bad Godesberg, Bundesminister fur Wissenschaftliche Forschung, 1964. 194p. DM 8,--.

The results of the measurements of the radioactivity in air, water, earth, and foods and the radiation burden of the population in the West German Republic are reported for the third quarter of 1964. The measurements are tabulated. (J.S.R.)

15817 DATA FROM RADIATION PROTECTION PROGRAMS. VOLUME 2. NUMBER 8. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). Aug. 1964. 46p.

Data are included on fallout, analyses, reactor environment monitoring, personnel dosimetry (film monitoring), isotope safety assessments, and field investigations of radiation safety. (P.C.H.)

15818 SAFETY STANDARD FOR NON-MEDICAL X-RAY AND SEALED GAMMA-RAY SOURCES. PART I. GENERAL. National Bureau of Standards Handbook 93. (National Bureau of Standards, Washington, D. C.). Jan. 3, 1964. 68p. $0.30(GPO)

Information is included on: classification of protective installations; selection of class of protective installation; plans for radiation installations; structural details of protective barriers; radiation protection surveys; and operating procedures. Various data and other information are appended. (P.C.H.)

15819 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG. BERICHT III/63. (Environmental Radioactivity and Radiation Protection. 3rd Quarterly Report, 63). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1963. 66p. 8,- DM.

The results of the measurements of the radioactivity in air, water, earth, and foods and the radiation burden of the population in the West German Republic were reported for the third quarter of 1963. The measurements are tabulated. (J.S.R.)

15820 VENTILYATSIYA PRI ROBATAKH S RADIOAKTIVNYMI VESHCHESTVAMI. (Ventilation During Operations Using Radioactive Substances). V. M. Krupchatnikov. Moscow, Atomizdat, 1964. 199p.

Radioactive substances and their effects on human organisms are reviewed. The principles of ventilation for reactor and accelerator installations and laboratories handling radioactive materials are discussed. Calculations for and construction of ventilation filters for waste purification are considered. Various centralized exhaust systems are described. (R.V.J.)

INSTRUMENTATION

General

Refer also to abstracts 15187, 15970, 16299, 16791, 17067, and 17194.

15821 (AEET/Spec./2) SETTING UP OF THE 22-FT. CONCAVE GRATING SPECTROGRAPH (EAGLE MOUNTING). K. V. S. R. Apparao, P. Ramakoteswara Rao, and G. D. Saksena (Atomic Energy Establishment, Trombay (India)). 1964. 31p. Dep.(mn).

A concave-grating spectrograph was mounted for studies of hyperfine and fine structure in atomic and molecular spectra. The principle and advantages of the Eagle-type mounting, and the various assemblies are described. The adjustments involved and the performance of the spectrograph are discussed. (D.L.C.)

15822 (AERE-M-1515) A DIFFRACTION GEOMETRY SUITABLE FOR HIGH- AND LOW-TEMPERATURE SINGLE-CRYSTAL WORK. J. F. W. Mallett and K. A. D. Lambe. Atomic Energy Research Establishment, Harwell (England). Jan. 1965. 8p. Dep.

A description is given of an arrangement enabling single-crystal specimens to be examined three dimensionally using a diffractometer, with little complication in the design of environmental control devices such as furnaces and cryostats. At least 85% of reciprocal space can be examined without physical shadowing by the apparatus, and the path length through furnace walls, is small and nearly constant. (auth)

15823 (BNL-8812) STABILITY OF A RHENIUM–GRAPHITE THERMOCOUPLE. F. J. Salzano (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 8p. (CONF-650204-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C.

Results are presented of tests made to assess the stability of a rhenium–graphite thermocouple at temperatures above 2000°C. The emf vs temperature behavior was measured at 800 to 2200°C after an anneal at 2200°C, and again after five further anneals at 2200°C. The annealing was found to change the emf vs temperature behavior, although the change rate decreased with subsequent anneals. The changes are attributed to diffusion of carbon into rhenium. The possibility of making a stable Re–C/graphite thermocouple is pointed out. (D.L.C.)

15824 (CRC-1211) A THERMISTOR-TYPE LIQUID N_2 LEVEL CONTROL SYSTEM. D. A. S. Walker (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1964. 9p. (AECL-2146). Dep.; $0.20(AECL).

A simple method of controlling the liquid N_2 level in an enclosed Styrofoam housing is described. By placing the sensor above the upper liquid N_2 limit, it is not subjected to the large thermal variations experienced in other thermistor-type systems. (auth)

15825 (LA-3199) AN EXPERIMENTAL VERIFICATION OF A COMPUTER PROGRAM FOR THE CALCULATION OF OSCILLATORY PRESSURE ATTENUATION IN PNEUMATIC TRANSMISSION LINES. Geoffrey P. Watts (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 1, 1964. Contract W-7405-eng-36. 35p. Dep.; $2.00(cy), 1(mn) CFSTI.

In order to study efficiently the characteristics of a nuclear reactor rocket engine (Rover project), it is necessary to measure the pressure of hydrogen at many locations. Both static and dynamic measurements are needed. Because of possible radiation damage to pressure sensing elements, they are placed behind radiation shields and connected by tubes to the regions to be measured. High frequency response suffers, usually showing pronounced resonance, as the tube length is increased. Equations describing the response have been derived by Iberall, and are sufficiently complicated so that they have never had wide use. A digital computer code has been devised which calculates the system behavior, using Iberall's equations. Laboratory experiments have been conducted using condenser microphones to measure the response of $\frac{1}{4}$-inch and $\frac{3}{8}$-inch-OD tubes. Reynolds numbers were all held to below 2000. The experimental and calculated results agree within experimental accuracy for intermediate lengths (4 to 8 feet) but diverge when the tubes become very short. The error in the calculated amplitude is inversely proportional to the square of the length over diameter ratio at the first resonant peak. The error of the resonant frequency at the first resonant peak is inversely proportional to the length over diameter ratio. (auth)

15826 (MLM-1163(p.1-1-12)) APPLICATIONS OF CALORIMETRY. B. C. Blanke, J. F. Eichelberger, and K. C. Jordan (Mound Lab., Miamisburg, Ohio).

Calorimeters are being used to measure heat generation by radioactive materials. The principles of the twin-bridge and thermoelectric calorimeters are described, and the interpretation of calorimeter results is discussed. Some high-temperature calorimeters are also described. The use of calorimetry in studies of irradiated Bi slugs, alpha irradiation of nitrogen oxides, and metabolic activity of an ant is considered briefly. (D.L.C.)

15827 (ORNL-TM-1032) LIGHT-ACTIVATED SWITCH BURNOUT DETECTION SYSTEM. W. R. Gambill (Oak Ridge National Lab., Tenn.). Jan. 11, 1965. Contract W-7405-eng-26. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A system for detecting incipient thermal burnout of resistance-heated test sections is developed, based on light-activated solid-state switches of the silicon PNPN type. These sensors, normally open, switch into conduction within a few μsec when the radiant intensity at the switch reaches ~3mw/cm² in the near-infrared and visible spectral regions. Sensitivity data for two types of light-activated switches are given, and a specific application to a two-phase boiling heat-transfer system is outlined. In addition to simplicity, low cost, and fast response, this method offers the advantages of allowing monitoring of the entire surface area of the test section, giving an indication of the location of overheating, and affording complete electrical isolation between triggering source and output. (auth)

15828 HIGH-RESOLUTION X-RAY COLLIMATOR WITH BROAD FIELD OF VIEW FOR ASTRONOMICAL USE. Minoru Oda (Massachusetts Inst. of Tech., Cambridge). Appl. Opt., 4: 143(Jan. 1965).

An x-ray collimator was designed, which permits greatly increased accuracy in the measurement of the angular size of the x-ray sources while using detectors with wide fields of view. The total flux of x rays detected while the source is in the field of view is essentially independent of the angular resolution regardless of how fine a resolution is required. The collimator was used for x-ray astronomy. (M.C.G.)

15829 INVESTIGATION OF CHARACTERISTICS OF THE LIGHT OF LUMINOPHORES BY MEANS OF BETA-RADIATION. Jan Fejtek and Milan Zavada. Chem. Prumysl, 14: 534-8(1964). (In Czech)

Equipment that makes it possible to establish optical characteristics of luminophores (i.e. sensibility to exciting radiation, kinetics of the excitation, and dying away stages) and to estimate the suitability of luminophores intended for excitement by means of an electron current is described. Some components of the device belong to standard equipment (a milliluxmeter with selenium cell, specimen exchanger); the instrument also includes an enclosed ^{90}Sr radioactive source of electrons. Measured data were compared for luminophores excited by a source of uv

radiation and ^{90}Sr derived raying, respectively. Results of quality estimations of some luminophores of Czechoslovakia and other proveniences are given, as well. (auth)

15830 EXCITING SUPPLY FOR MAIN MAGNET OF ETL MASS SPECTROMETER. Kogoro Maeda. Denki Shikensho Iho, 28: 514-22(July 1964). (In Japanese)

Power transistors were used for regulation of current over nearly 0 to 15 amp for deflection of the positive ion beam in a mass spectrometer. To keep the voltage of the transistor constant over the wide range of the current, a system was adopted in which primary power supply was changed through a dynamic transformer in response to the current. A scanning system was designed so that the intervals of scanning could be set arbitrarily and repeated automatically. Performance tests showed that the power supply was good enough for use as part of the mass spectrometer; it had a stability of the order of 10^{-4} to 10^{-5} over the current range of 1 to 15 amp. (auth)

15831 ION COLLECTOR ASSEMBLY OF ETL MASS SPECTROMETER. Kogoro Maeda. Denki Shikensho Iho, 28: 523-9 (July 1964). (In Japanese)

For a mass spectrometer with an 80-cm ion radius and a 3-ton magnet, the focusing point of which was found by Cartin's schematic treatment to move mainly along the beam direction despite of any displacement of the magnet, a collector assembly adjustable along the ion beam direction was designed. To adjust the position of the collector, a very thin 4-in. gate valve was installed near the collector assembly, and a special arrangement was made for the recording system so that the operator could handle the spectrometer with no difficulty. As a result of some performance tests it was found that the assembly of the collector including the recording system and the gate valve was sufficiently reliable. (auth)

15832 THE RESONANCE PROBE. A TOOL FOR IONOSPHERIC AND SPACE RESEARCH. F. W. Crawford and R. S. Harp (Stanford Univ., Calif.). J. Geophys. Res., 70: 587-96(Feb. 1, 1965).

Experiments on the r-f impedance between two probes immersed in a plasma and on the incremental d-c characteristics of an r-f modulated probe suggested that resonance effects occur at the local electron plasma frequency ω_p. Ionospheric electron density measurements based on these experiments were made previously. It is shown that the two resonance effects are closely related but that the resonant frequency lies below ω_p. The complicated detailed theory of resonance probe behavior yields a simplified model agreeing well with experiment. This model is applied to several probe geometries of interest, and additional r-f techniques are suggested which may prove superior to incremental d-c observations for transmission of data. The various regions of applicability of the resonance probe in space are discussed, and it is concluded that a detailed theory of the effects of magnetic field on the resonance is required to increase its usefulness for ionospheric probing. (auth)

15833 A FIZEAU DILATOMETER FOR IRRADIATED SPECIMENS. A. A. McFarlane (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Sci. Instr., 42: 24-7(Jan. 1965).

An interferometric dilatometer, for measurement of the absolute thermal expansion of small specimens of irradiated materials, is described. Because of dimensional changes on irradiation, specimens do not usually retain sufficient parallelism as supports for the interferometer plates; this instrument was designed to accommodate specimens within wider limits. (auth)

15834 AN INVERTED LIQUID ARGON CRYOSTAT. F. J. Webb (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Sci. Instr., 42: 41-2(Jan. 1965).

A cryostat was designed, which has a large reservoir for the coolant below the object to be cooled. The coolant level is maintained constant at the top of the cryostat by a simple level control actuated by a float. (auth)

15835 SYNCHRONIZATION OF PULSES TO THE PHASE OF A 20 MHz SINE WAVE. A. Langsford, P. E. Dolley, and G. B. Huxtable (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 33: 57-60(Mar. 1, 1965).

Pulses generated at a random phase of an r-f sine wave are synchronized to some constant phase. The jitter in the phasing is less than 0.1 ns, and the circuit can accept sine waves in the frequency range 17 to 30 MHz. (auth)

15836 A FAST PULSE TRAIN GENERATOR. B. Righini (Universita, Bologna). Nucl. Instr. Methods, 33: 114-19(Mar. 1, 1965).

A pulse train generator capable of giving trains of fast pulses is described. The instrument, that may be used in testing electronic circuits to be used in high energy nuclear physics experiments gives an output formed by trains of pulses of both polarity 10 v amplitude and 3.5 ns rise time, whose time separation may be changed between 60 and 300 ns. The diagram of the circuit is reported, together with long term and temperature tests. (auth)

15837 ON THE DESIGN OF WIDE RANGE ELECTROMAGNETS OF HIGH HOMOGENEITY. A. Huber and H. Primas (Swiss Federal Institute of Tech., Zurich). Nucl. Instr. Methods, 33: 125-30(Mar. 1, 1965).

The design of high homogeneity iron-electromagnets without any local saturation up to 24 kG is discussed. An advantage of such a design is the complete independence of the field geometry on the field strength in the whole working range. A practical design procedure is given, based on a model calculation of an ideal pole shape. The results are applied to the construction of a magnet for high resolution nuclear magnetic resonance spectroscopy in the range of 0-24 kG. (auth)

15838 NON-INTEGRATING STRETCHER FOR PULSES OF 6 TO 300 ns LENGTH. C. Weddigen and E. L. Haase (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Instr. Methods, 33: 157-8(Mar. 1, 1965).

A non-integrating pulse stretcher is described. During the rise time of the input pulse the quiescent current of an emitter follower with capacitive load is interrupted for some time by a tunnel-diode generator triggered by the input pulse. At the end of the trigger pulse, the quiescent current of the emitter follower is switched on again and discharges the load capacitor rapidly. Thus at this capacitor one gets a rectangular pulse with the same amplitude as that of the input pulse. This principle combines high speed and good linearity without the usual pile-up effects, the dead-time being that of the tunnel-diode generator. (C.E.S.)

15839 A 1 ns RISETIME AMPLIFIER WITH DIRECT COUPLING. H. G. Jackson (Univ. of California, Berkeley). Nucl. Instr. Methods, 33: 161-3(Mar. 1, 1965). (UCRL-11819)

The design of a transistorized direct-coupled amplifier with a risetime of 1 nsec is presented, and the amplifier performance is discussed. (C.E.S.)

15840 ELECTRON AND ION INSTABILITIES IN DIODES. V. C. Boffi, V. G. Molinari, D. E. Parks, and R. Schozzafava (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). Nuovo Cimento (10), 36: 150-64 (Mar. 1, 1965).

Criteria for the stability of a collisionless plane diode containing an uniform density of infinitely heavy ions in the interelectrode space are obtained. All electrons are assumed to be emitted from the cathode of the diode with a single velocity and every emitted electron is finally absorbed at the collector surface. Thus although the theory applies only in the case where there are no reflected currents, it does take account of potential inhomogeneities induced by space charge. The stability criterion is obtained in the form of an exponential polynomial. This polynomial is studied in detail for the case of a diode without a neutralizing positive ion background, thereby extracting from the theory a very simple stability criterion. The result was applied to the case of a diode operating at short circuit. Ion instabilities are also studied. In this case useful results were obtained only for the case of a diode in which the space charge is completely neutralized. (auth)

15841 ELECTRON MICROSCOPY WITH HIGH-FIELD SUPERCONDUCTING SOLENOID LENSES. Humberto Fernandez-Moran (Univ. of Chicago). Proc. Natl. Acad. Sci. U. S., 53: 445-51(Feb. 1965).

In a series of experiments with a simple electron microscope without pole pieces, using high-field superconducting niobium–zirconium solenoid lenses in an open-air-core, liquid-helium Dewar, electron microscopic images of test specimens were recorded while operating at 32,200 kg in a persistent current mode, with accelerating potentials of 4-8 kv. Preliminary results demonstrated the exceptional stability of the images (both short-term and long-term) over a period of 4-8 hr, and the relatively high quality of the images at magnifications of 50-100×. The results obtained with this experimental approach and some interesting observations bearing on imaging phenomena with superconducting solenoids are described. (auth)

15842 MICROWAVE DISCHARGE CAVITIES OPERATING AT 2450 MHz. F. C. Fehsenfeld, K. M. Evenson, and H. P. Broida (National Bureau of Standards, Boulder, Colo.). Rev. Sci. Instr., 36: 294-8(Mar. 1965).

Five simple microwave cavities for producing discharges in gases were tested in He and H_2 at pressures from 1 μ to 1 atm. Three of the cavities are commonly used, and two were recently designed. One of the newly designed cavities offered a considerable improvement over early models with respect to compactness, ease of attachment to the system, and efficiency. (auth)

15843 GENERATION AND DIAGNOSIS OF SYNTHESIZED PLASMA STREAMS. J. M. Sellen, Jr., W. Bernstein, and R. F. Kemp (TRW Space Tech. Labs., Redondo Beach, Calif.). Rev. Sci. Instr., 36: 316-22(Mar. 1965).

A contact-ionization source is described which generates a cesium ion stream characterized by a high degree of order in the ion motion. Electrons are added to form a quiescent, collisionless plasma stream. Diagnostic instruments are described for demonstrating the properties of the plasma streams. Ion densities range from 5×10^7 to 1×10^{11} ions/cm^3 in the source region, at accelerating voltages from 100 v to a few thousand volts, depending on the experimental application. Conical expansion of the beam reduces the densities in downstream regions. Electron temperatures in the beams range downward from the ~2500°K emissive wire temperature. Means are described for increasing electron temperatures to several times this value, with resultant increase in beam divergence. (auth)

15844 GAMMA-RAY ABSORPTION INSTRUMENT FOR DETERMINING FLUID SATURATION OF CORES. P. J. Closmann and W. R. Orr (Shell Development Co., Houston, Tex.). Rev. Sci. Instr., 36: 346-55(May. 1965).

An instrument is described for measuring fluid saturation in cores by means of gamma absorption. Results of this technique are compared with those from electrical resistance measurements. Good agreement is found for gas-liquid systems under conditions of comparatively slow saturation change. For rapidly moving fronts the instrument responds quickly to the arrival of a saturation gradient, but does not give an accurate measure of saturation in the region of the front. (auth)

15845 CALIBRATION OF VACUUM GAUGES AT PRESSURES BELOW 10^{-9} TORR. W. S. Kreisman (Geophysics Corp. of America, Bedford, Mass.). p.27-38 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

A method of calibrating vacuum gauges (or other gas measuring devices such as mass spectrometers, etc.) at very low pressures is described. Calibrating gas is flowed into the test chamber of a ultra-high-vacuum Venema type mercury diffusion pump system at a series of known rates and is removed at a known constant speed. In this way, a series of known equilibrium pressures are established in the test chamber. Practical aspects of the method are discussed, and an example of a typical flow calibration is presented. (auth)

15846 ULTRA-HIGH VACUUM USE OF BAYARD-ALPERT IONIZATION GAUGES II. Thomas E. Hartman (Texas Instruments Inc., Dallas). p.39-51 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

Anomalously high residual collector current is observed with a Bayard-Alpert ionization gauge after the gauge has been exposed to a relatively high pressure gas which will chemisorb on the grid of the gauge. The evidence indicates that the principal portion of the anomalous residual current results from the subsequent release of the adsorbed species as high velocity ions. A small fraction of the fast ions collide with the collector resulting in a positive charge flow from the grid to the collector which is pressure independent. The more strongly chemisorbed gases are found to replace those which have been previously adsorbed. Oxygen results in the largest and most persistent anomalous residual current. (auth)

15847 DEVELOPMENT AND USE OF AN ION MACH METER TO CALIBRATE AN ARC-HEATED LOW-DENSITY WIND TUNNEL. W. A. Clayden (Royal Armament Research and Development Establishment, Fort Halstead, Kent, Eng.). p.981-1012 of CONF-752(Pt.II).

A method is given that enables a local measurement of ion Mach number to be obtained directly in a flowing partially ionized gas. Essentially it is shown that the ion Mach number is proportional to the ratio of the saturated ion currents obtained from a double Langmuir probe with electrodes aligned parallel and normal to the flow. For the method to be valid it is necessary for conditions to hold: velocity > ion velocity at the sheath edge $\simeq\sqrt{kT_e/m_i}$; electron temperature $\gg$ ion temperature; and Debye length $\ll$ probe diameter $\ll$ neutral mean free path. Experiments show that these conditions may be obtained in the RARDE arc-heated low-density wind tunnel and the optimum probe sizes are obtained. The method of extrapolating the saturated ion currents to their value at plasma potential is discussed. The ion Mach meter is then used to calibrate a contoured nozzle and a free jet. The maximum ion Mach number that is obtained is ~2.4, which is in qualitative agreement with a simple model in which the electron temperature is constant throughout the nozzle or jet and equal to the neutral gas stagnation temperature. (auth)

15848 A PRECISION MISSILE LIFT OFF MEASUREMENT SYSTEM UTILIZING GAMMA PHOTON RADIATION. A. J. Campanella (Industrial Nucleonics Corp., Columbus, Ohio). 3p. (CONF-501-2)

From Western Electric Show and Conference and IEE Summer General Meeting, Los Angeles, Aug. 1964.

An all-weather tracking system was needed for the accurate tracking of a missile at low altitudes during the lift-off phase. The feasibility of using a gamma source attached to the missile and a directional detector on the ground was studied. The performance of a detector with a parallel-plate collimator was determined. The parameters of source strength, detector area, beamwidth, and data smoothing times for the required accuracies were calculated, and the accuracies of position, velocity, and acceleration measurements at an altitude of 500 ft are given. (D.L.C.)

15849 STUDY, DESIGN AND APPLICATIONS OF BETA EXCITED X-RAY SOURCES. J. J. Ezop and T. G. Stinchcomb (Illinois Inst. of Tech., Chicago). 47p. (CONF-641017-1)

From Symposium on Low Energy X and Gamma Sources and Application, Chicago.

A review is presented of the results of several studies on the characteristics (yield and spectral distribution), designs, and uses of beta-excited x-ray sources. These include an analytical study of x-ray production (both bremsstrahlung and characteristic x rays) in several source-target configurations and a comparison with the results of experimental investigations using ^{147}Pm, ^{85}Kr, and ^{90}Sr (^{90}Y) sources with tin and lead target materials. The good agreement between calculated and experimental data makes

possible the optimization of the design of beta-excited x-ray sources to meet the requirements of specific applications. The design, yield and spectral distribution of prototype sources are discussed, along with their performance in practical applications of thickness gaging, fluorescent excitation, critical absorptiometry, and radiography. (auth)

15850 RAMSES, A FLEXIBLE DATA COLLECTING AND RECORDING SYSTEM FOR NUCLEAR MEASUREMENTS. J. Bjoerkman. (CONF-640902-7) Acta IMEKO (Intern. Messtech. Konf.), 1964, 475-92.

An instrument for automatic collection and recording of digital data is described. The input data are pulses from pulse-type nuclear detectors or pulse trains from an analog-to-digital converter. The input pulses are counted and the numbers obtained transferred to an output device, a paper tape perforator, a typewriter, or a magnetic tape recorder. The equipment consists of three main units, a control unit for reading and printing the information, a program, and a register unit. These two latter units are constructed on a plug-in board system. Because of this modular system the equipment is very versatile. The user sets up the scalers needed for a specific experiment in the register unit, and in the program unit he inserts circuit boards as required to obtain automatic operation. Among applications of the equipment are mapping of neutron flux fields, reactor noise measurements, and collecting data from accelerator experiments. (auth)

15851 MASS SPECTROMETER LEAK DETECTOR INCLUDING A NOVEL REPELLER-HEATER ASSEMBLY. John L. Peters. U. S. Patent 3,155,826. Nov. 3, 1964. Filed Dec. 29, 1961.

Leak rates as low as approximately 10^{-11} standard cc/sec were detected by a sector field mass spectrometer leak detector having a single analyzing stage. This sensitivity was achieved by improvements in the construction of the repeller-heater assembly used in the ion source, the choice of the ion beam accelerating voltage used in the leak detector, and the d-c electrometer amplifier. In the repeller-heater assembly, the repeller is constructed so that its ion repelling face remains fixed relative to the elements of the ion source even though the repeller is heated to a high temperature. The heater is insulated from the repeller. The voltage gradient across the repeller is adjustable, and the heater may be energized independently of the voltage gradient across the repeller. The ion beam accelerating voltage is approximately double the usual voltage for sector field leak detectors. In the d-c electrometer amplifier, drift is minimized by providing means for heating the filament of the input pre-amplifier tube to its operating temperature before supplying other operating voltages to the tube. (A.G.W.)

15852 RADIOACTIVE FLUID FLOW MEASURING APPARATUS WITH MEANS FOR INJECTING A MARKER MATERIAL BETWEEN THE SOURCE AND DETECTOR. Richard L. Caldwell (to Socony Mobil Oil Co.). U. S. Patent 3,156,818. Nov. 10, 1964. Filed July 25, 1960.

An apparatus for flow measurement in remote locations such as boreholes or pipelines is described. The device consists of an elongated tubular member whose intermediate portion forms a longitudinally oriented flow channel with an inlet port and an outlet port spaced apart along the length of the flow channel. A source of γ radiation is placed at one end of the channel and a detector of γ radiation at the other end. Means are provided near the inlet port for injecting into the flow channel a material that modifies the γ transmission of the fluid. The time during which the γ transmission is modified reflects the time necessary for the modifying material to pass through the flow channel and thus indicates the flow rate. In a variation of the device, the γ source is omitted and a radioactive material is injected near the inlet port. A further modification of the device permits isolation of a given section of a borehole and measurement of the flow therefrom. (A.G.W.)

Radiation Detection

Refer also to abstracts 15015, 15047, 15597, 16423, 16879, and 16959.

15853 (ANL-6897) A STUDY OF THE 1/E SLOWING-DOWN NEUTRON SPECTRUM USING 4π-RECOIL PROPORTIONAL COUNTERS. Edgar F. Bennett (Argonne National Lab., Ill.). Sept. 1964. Contract W-31-109-eng-38. 41p. Dep.; $2.00(cy), 1(mn) CFSTI.

The response to a 1/E neutron spectrum of a hydrogen-filled proportional counter in the energy region below 100 kev was studied using pulse-shape discrimination to reject gamma-induced background. The observed proton-recoil distributions permitted an evaluation of W (the energy loss per ion pair) for protons in hydrogen below 10 kev. Some problems associated with the use of 4π-recoil proportional counters as neutron spectrometers were considered including calibration, optimization of neutron-to-gamma ratios, and resolving power. (auth)

15854 (BNL-8817) THE HEAVY LIQUID BUBBLE CHAMBER FOR A 1000-Bev ACCELERATOR. A. Rousset (Brookhaven National Lab., Upton, N. Y.). Jan. 14, 1965. Contract AT-30-2-GEN-16. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The heavy liquid bubble chamber is discussed as the detection system for accelerators in the range of 1000 Bev. The use of the bubble chambers for investigating high-energy interactions of strongly interacting particles and neutrino interactions is considered. The design and construction of a chamber are discussed. (C.E.S.)

15855 (CEA-R-2457) APPLICATION DES TUBES A MEMOIRE A LA REALISATION D'UNE MEMOIRE TAMPON. (Use of Charge Storage Tube in the Building of a Buffer Memory). Claude Marcovici (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 104p. Dep.(mn).

Thesis submitted to Université, Grenoble, France.

The apparatus described is a buffer memory to be located between a detector and a multichannel pulse-height analyzer, which received the pulses at regular times. The buffer memory and the detector have the same order of dead time, so the whole is equivalent to a detector plus an analyzer without dead time, but that is true only if the mean time between two consecutive pulses from the detector is greater than the analyzer time resolution. The apparatus used two electrostatic barrier grid tubes; the first one temporarily stores the data from the detector during the time necessary to analyze the data recorded on the other one. At the end of the analysis, the roles of the two tubes are permuted. The advantage compared with similar apparatus is the uninterrupted recording of the pulse height information from the detector and uninterrupted analysis. In addition, the transistorization is interesting for reliability and maintainability. The analysis presents principles and data on the barrier grid storage tube, considers its conventional uses in nuclear electronics, and studies statistically the reduction of counting losses. It describes the test equipment and the tests that permit the screening of the best cathode ray storage tube for this application. Finally, it describes the item and gives the wave shapes in various points of the buffer memory. (auth)

15856 (DPSPU-64-30-3) PROGRESS IN HEALTH PHYSICS INSTRUMENTS. C. N. Wright (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Plant). Apr. 1964. Contract AT(07-2)-1. 14p. (CONF-642-23) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Health Physics Society, Cincinnati, June 1964.

A summary is presented of the development of health-physics survey instruments, counting-room instruments, emergency instruments, and personnel-monitoring instruments. Thirty-eight references. (T.F.H.)

15857 (GEAP-4747) THEORY OF THE CAMPBELL SYSTEM OF REACTOR INSTRUMENTATION. Quarterly Progress Report, July–September 1964. J. P. Neissel (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.) Oct. 1964. Contract AT(04-3)-189. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Equations are derived that can be used in a Campbell system for radiation measurement. Derivations and results in the most general form for application to any system are included along with results for a system that contains one

high-pass filter and one low-pass filter. The latter results are easier to use and sufficiently accurate for use with most systems. (J.R.D.)

15858 (IDO-11401(p.355-78)) DOSIMETRY. M. A. Sweeney (California Research Corp., Richmond).

The methods used in the measurement of radiation dose rates in the Organic Reactor Program are described. The methods were used for charged particles, gamma rays, and reactor radiations. Information pertinent to the application of each method is given. (D.L.C.)

15859 (JINR-E-1866) SOME ASPECTS OF APPLICATIONS OF PHOTOGRAPHIC EMULSIONS. K. D. Tolstov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1964. 9p. (CONF-787-3). Dep.(mn).

From 5th International Conference on Nuclear Photography, Geneva, Sept. 1964.

Some improvements in the emulsion technique are suggested. Experiments to be performed at accelerators and in cosmic rays are discussed. It is also proposed to use hydrogen targets and polarized protons. (auth)

15860 (K-L-6021) TEST AND ADJUSTMENT PROCEDURE MANUAL. FIXED FILTER PAPER ALPHA AIR MONITOR — MODEL A (K-1589). G. B. Seaborn (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 26, 1965. Contract W-7405-eng-26. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tests for one of the capacitors in the unit are given for checking a new component or rechecking an existing component for possible deterioration. Adjustment procedures are given for newly constructed instruments. Also given are oscillograms to be expected at various test points, test results obtained on the five original units, and a schematic diagram and parts list. (D.L.C.)

15861 (NDL-TR-46) THE EFFECT OF NEUTRONS WITH ENERGIES ABOVE 6 Mev ON FISSION FOIL DATA. Jean Kappes and John H. McNeilly (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Oct. 1964. 27p.

A calculational correction to neutron-flux measurements that were made using fission foil detectors exposed to a radiation environment in which approximately 7.5 percent of all neutrons had an energy greater than 6 Mev is described. This investigation showed that in many cases it will be necessary to correct the fission foil results because of the increased cross section at high neutron energies. In the particular example presented, where 7.5 percent of the total number of neutrons had energies greater than 6 Mev, the correction for ^{238}U ranged between 21.9 and 27.3 percent and was marginal for ^{237}Np (7.2 to 10.6 percent). Although corrections existed for the remaining foils, they were all within the quoted experimental error of ±10 percent for the threshold detector system. It is expected that significant corrections will have to be applied to most foil data when they are exposed to neutron spectra containing larger percentages of neutrons with energies greater than 6 Mev. This investigation describes an approach to the solution of the problem posed by high energy neutrons on threshold detector results, and emphasizes the fact that the problem must be considered in all future applications of this measurement technique. (auth)

15862 (NP-14629) APPAREIL DE MESURE DE PHOTOGRAPHIES DE CHAMBRES A TRACES, EN COORDONNEES BIPOLAIRES. (Apparatus for Measurement of Photographs of Track Chambers in Bipolar Coordinates). Xavier Sauteron (Ecole Polytechnique, Paris (France)). [1962]. 71p. Dep.(mn).

Thesis submitted to Université, Paris.

The essential characteristics of the BP3 (the heavy liquid bubble chamber), of the tracks to be measured, and of the projector designed for this chamber are briefly described. The general principles of the measurement device, consisting of a projection table and a coating system, are given. The sighting system connected to two coders is described. The device for recording data on IBM cards and tests performed to verify the good performance of the mechanical part of the device are examined. The results on the precision attained and the speed of the measurements are given and compared with those of a classical instrument for the study of photographs. (J.S.R.)

15863 (NP-14649) CONTRIBUTION A LA MISE AU POINT D'UN DISPOSITIF DE MESURES AUTOMATIQUES DE CLICHES DE CHAMBRES A TRACES (THESES). (Contribution to the Development of an Automatic Measuring Apparatus for Track Chamber Plates (thesis)). Michel Benot (Grenoble Univ. (France)). [1963]. 139p. Dep.(mn).

The development, construction, and performance of the Hough-Powell device (H.P.D. MARK I) were described. The mechanical precision and the precision on the track localization, the first analysis of events produced in bubble chamber, development of the MILADY premeasurement table, and the quality of the Wray objectives were studied and presented. The principal characteristics of the H.P.D. MARK I and MARK II were tabulated. (J.S.R.)

15864 (NP-14690) OBRATNOE RASSEYANIE GAMMA-LUCHEI V SCTINTILLYATSIONNYKH SCHETCHIKAKH. (Gamma-Ray Back-Scattering in Scintillation Counters). S. A. Baldin (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 1963. 8p. Dep.(mn).

A systematic study was made of gamma backscattering in scintillation detectors as a function of the thickness, type of diffusing material (at the diffuser-detector contact), and geometrical dimensions of the shielding. Experimental data were used for constructing graphs of backscattering as a function of the atomic charge and the specific gravity of the material. (R.V.J.)

15865 (NP-14692) ZAPOMINAYUSHCHIE UST-POISTVA NA 4096 CHISEL DLYA MNOGOKANAL'NYKH I MNOGOMERNYKH ANALIZATOROV. (A 4096-Address Storage System for Multi-channel and Multi-dimension Analyzers). A. L. Belous, S. S. Kurochkin, V. V. Pashvykin, and G. P. Pekhov, (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1963]. 18p. Dep.(mn).

A 4096-address storage system for multichannel and multidimensional analyzers was constructed using three and four coordinate variations of storage systems operated by semiflow coincidence systems. (R.V.J.)

15866 (NP-14699) LENTOPROTYAZHNYE MEKHANIZMY AEROSOL'NYKH RADIOMETROV. (Band Transport Mechanism for Aerosol Radiometer). R. K. Dmitriev (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1963]. 12p. Dep.(mn).

Descriptions are given of a typical design, construction, and operation of a band transport mechanism used with aerosol radiometers. Two types of band transport mechanisms (continuous and step-by-step) are shown for the filtering band. (R.V.J.)

15867 (NP-14701) PREOBRAZOVATEL VPEMENI V AMPLTUDU. (A Time-to-Amplitude Converter). B. G. Egiazarov, O. A. Karpukhin, and Yu. A. Krutyakov (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 8p. Dep.(mn).

A design is given of a time-to-amplitude converter and amplifier. The transformer was used for determining positron lifetimes in various substances. Investigations showed the presence of two components in the substances. The first component with a short lifetime of 10^{-10} sec was assigned to the decay of the positronium singlet (^1S state) and free positron annihilation. The second component with the lifetime (in various substances) from 5×10^{-10} to 3.5×10^{-9} sec was assigned to the decay of ortho-positronium (^3S state). Probabilities of $^3S \rightarrow {}^1S$ transitions depend on electron structure of the substance. Results obtained for Teflon and water are tabulated. (R.V.J.)

15868 (NP-14704) POGRESHNOSTI PRI GRADUIROVKE GAMMA-DOZIMETROV V KOLLIMIROVANNOM PUCHKE. (Errors in the Calibration of Gamma Dosimeters in a Collimated Beam). E. F. Garapoy, Yu. N. Gryaznov, and G. A. Dorofeev (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 8p. Dep.(mn).

An attempt was made to determine the variations in the

radiation spectrum due to changes in the collimated beam opening angle and in the distance between the detector and emitter. The means for reducing the radiation scattering intensity were analyzed. The results showed that the main part of diffusing radiation in a collimated beam appeared in the shielding and collimator materials near the source. (R.V.J.)

15869 (NP-14715) NALICHIE "PLATO" V SCHETNOI KHARAKTERISTIKE STSINTILLYATSIONNOGO DATCHIKA GAMMA-IZLUCHENIYA I EGO PRACTICHESKOE ISPOL'ZOVANIE. (The Presence of a "Plateau" in the Counter Characteristic of a Scintillation Gamma-Detector and its Practical Utilization). I. I. Kreindlin, R. A. Markova, L. M. Ioannesyants, and A. S. Il'ina (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 8p. Dep.(mn).

An analysis was made of the presence of a plateau in the counting characteristics of a scintillation γ detector and on its practical uses. Tests carried out with 150 scintillation transducers with FEU-29, -24, and -37 photomultipliers and NaI(Tl) crystals showed the presence of a counting plateau in all cases. The mean width of the plateau was from 100 to 350 v and the inclination was 2 to 5% per 100 v. The data on the presence of plateau is taken into account for increasing detector efficiency. (R.V.J.)

15870 (NP-14716) KOMPLEKS USTROISTV I BLOKOV DLYA MNOGOKANAL'NYKH I MNOGOMERNYKH ANALIZATOROV. (Systems and Units for Multi-channel and Multidimensional Analyzers). S. S. Kurochkin, A. F. Belov, A. L. Belous, I. S. Krasheninnikov, V. N. Salichko, E. I. Rekhin, and V. A. Fateev (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 17p. Dep. (mn).

Descriptions are given of the new systems and units for various types of multichannel and multidimensional analyzers. Tabulated data and specifications of the inlet and outlet impedance units and inlet and outlet signal parameters, coding, and memory devices are discussed. (R.V.J.)

15871 (NP-14732) METODIKA GRADUIROVKI NEITRONNYKH PADIOMETROV. (Methods of Calibrating Neutron Radiometers). R. D. Vasil'ev, G. A. Dorofeev, T. S. Mordovskaya, V. I. Petrov, and M. I. Pimenov (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 7p. Dep.(mn).

Descriptions are given of a method for calibrating gamma-insensitive neutron radiometers used for measuring the density of thermal, intermediate, and fast neutrons. A method of cadmium differences using a 150 mm paraffin sphere with a (α,Be) neutron emitter in the center and a 1 mm cadmium screen was used for calibrating for thermal neutrons. Photoneutron emitters were used for intermediate neutron radiometers, and (α,Be) emitters were used for the fast neutron radiometers. (R.V.J.)

15872 (ORNL-3714(Vol.I)(p.78-86)) RADIATION DETECTOR STUDIES. [PART] I. (Oak Ridge National Lab., Tenn.).

Research is summarized on proton-recoil scintillation neutron spectrometers, organic scintillator response to fast neutrons, development of high- and low-energy neutron spectrometers, and development of fast-neutron dosimeters. (J.R.D.)

15873 (ORNL-3714(Vol.II)(p.134-46)) RADIATION DETECTOR STUDIES. [PART] II. (Oak Ridge National Lab., Tenn.).

Research is summarized on organic phosphor efficiency in neutron detection at 14.4 and 2.6 Mev, light response of organic phosphors to charged particles, modification of 400-channel pulse-height analyzers, capacitor development for nanosecond circuits, instrument response unfolding, tunnel-diode descriminator design, strip-line construction for nanosecond circuitry, performance of nanosecond circuitry, light pipe development for organic scintillators, nanosecond light sources for gain stabilization, fabrication of thick B targets, constant current sources, and calculation of organic scintillators for fast neutrons. References to publications in which the research is described are included. (J.R.D.)

15874 (PAN-561/IX-A) REACTOR DETECTORS DEVELOPED SINCE 1963. Jadwiga Jablonska, Andrzej Janikowski, and Jerzy Topa (Polish Academy of Sciences Warsaw. Inst. of Nuclear Research). Nov. 1964. 21p. Dep.

New types of detectors developed for reactor control systems and for some measurements in reactor physics are described. These are: pulse-fission chamber with uranium-235; boron ionization chambers, compensated for gamma radiation and uncompensated; threshold fission chambers with thorium-232; and small ionization chambers for gamma scanning. The construction of the detectors is shown and the main parameters are given. (auth)

15875 (TID-21213) DEVELOPMENT OF A HIGH-SPEED PHOTOMULTIPLIER. Progress Report, January 2–July 2, 1964. G. R. Feaster (Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.). Contract AT(30-1)-2825. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The reproducible fabrication of high-speed photomultiplier tubes incorporating transmission secondary-emission dynodes is studied. Work on a hybrid design incorporating Ag–Mg mesh dynodes was terminated, and attention was turned to tubes using only transmission-type dynodes. Increased attention is being given to discovery causes of, and methods for reduction of, dark current. An experiment was run in which post-exhaust pumping was accomplished with an ion gage attached to the multiplier with copper tubing. (auth)

15876 (UCRL-12401-T) GAMMA RADIATION MONITORING RADIO TELEMETRY SYSTEM. J. G. Nish, P. L. Phelps, and G. Holladay (Lawrence Radiation Lab., Univ. of California, Livermore). [1962]. Contract [W-7405-eng-48]. 24p. (CONF-650404-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From National Telemetering Conference, Houston.

The prototype of a system for measuring gamma radiation at predetermined locations over several thousand square miles of terrain is described. The system consists of several (up to 100 units) FM-FM telemetry linked remote sensors connected via portable repeater stations to a central data collection center. All measurement and calibration functions are performed on command. Power for the remote units is supplied from rechargeable batteries. The system is highly portable; the remote sensors and repeaters may be fielded by helicopter. (auth)

15877 ABSOLUTE DETERMINATION OF THE NUMBER OF NEUTRONS EMITTED BY A SOURCE. I. A. Yaritsina. Acta IMEKO (Intern. Messtech. Konf.), 1964, 493-508. (CONF-640902-2)

Three methods used in the Mendeleev Institute of Metrology for measuring the absolute number of neutrons emitted by a source are considered. The first method is based on comparing the flux of neutrons from the source with the flux of neutrons obtained in the $T(d,n)^4He$ reaction. The second method is based on absolute measurement of ^{56}Mn activity obtained from neutron source placed in the center of a tank filled with sulfuric manganese solution. Manganese activity is measured by a scintillation detector. In the third method the distribution of neutrons in water was investigated by means of a miniature boron counter, and the neutron-induced gold-foil activity was measured. Accuracy of the methods is within 2–3 percent. (auth)

15878 NEW TYPES OF MAGNETIC BROAD-RANGE HEAVY-PARTICLE SPECTROGRAPHS. Martti Bister (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 154, 1-37(1964).

Tables and graphs are presented of the specifications and performance, varying within wide limits, of new homogeneous-field, broad-range, heavy-particle spectrographs. The focal curve of the spectrographs has an inflection point at the focal point of the second order, corresponding to the

central radius of curvature. For other possible radii of curvature, a second-order aberration is generally small. Inspection of the curvature of the focal curve shows that it is negligible at least over the energy range from E_{min} to $E_{max} = E_{min}$ even when the fringing field is taken into account. (auth)

15879 MEASUREMENT AND STABILITY CONTROL OF RADIOACTIVE PREPARATIONS. V. M. Malykhin. At. Energ. (USSR), 18: 73-5(Jan. 1965). (In Russian)

A statistical analysis was made of detector apparatus. Counting rates for identical activity specimens were carried out using the same background criterion. With the number of preparations per one background m the measuring is of the m + 1 type. Optimum distribution of total measuring time was investigated. The accuracy of counting rate is determined by the type of m, total measuring time T, absolute calculation rate n_a, and the ratio of preparation and background rates. The stability of the detector was analyzed and evaluated. (R.V.J.)

15880 INFLUENCE OF STORAGE IN LIQUIDS OF NUCLEAR EMULSION ON α TRACKS AND THORON DIFFUSION. Dan Anghelescu (Polytechnical Inst., Bucharest). Bul. Inst. Politeh. Bucuresti, 26: 39-42(Mar.-Apr. 1964). (In Rumanian)

In nuclear emulsions exposed in different organic liquids the increase in length of α tracks and the enhanced diffusion of thoron atoms were investigated. Quantitative characteristics in this respect are given for each liquid. (auth)

15881 AN AUTOMATIC RADIOACTIVITY COUNTER (EXCHANGE OF EXPERIENCE). V. V. Kotelev and L. A. Shakun. Byul. Tekhn.-Ekon. Inform., [Sov. Nar. Khoz. Ivanovsk. Ekon. Adm. Raiona], No. 11, 54-5(1964).

An automatic radioactivity counter was developed, consisting of an aluminum bed with a control panel, a printing block, an aluminum target-bearing disk, and a closed lead box with a counter tube. The apparatus guides the targets covered with radioactive specimens under the tube, interchanges them, records the time during which the impulses are counted, and prints the target numbers. It is also capable of taking radioactivity counts on a paper chromatogram, of handling either 50 or 25 specimens (depending on whether target diameters are 18 or 25 mm) and of stopping and automatically switching itself off. (OTS)

15882 FET DETECTS ALPHA PARTICLES BETTER AND MORE PRECISELY. Charles R. Seashore and Clement D. O'Brien (Honeywell, Inc., St. Paul, Minn.) Electronics, 38: No. 3, 64-6(Feb. 8, 1965).

The advantages of alpha detection circuits using field-effect transistors (FET) as both the detector and first-stage amplifier over circuits using p-n junction diodes as the detector are discussed. The FET provides at least a tenfold increase in the signal-to-noise ratio. (D.C.W.)

15883 TIME-DISTRIBUTION OF EVENTS AT THE OUTPUT OF SYSTEMS WITH VARIABLE DEAD-TIME. I. De Lotto (CNR-CISE, Milan) and P. F. Manfredi. Energia Nucl. (Milan), 12: 95-7(Feb. 1965).

The time distribution of events at the output of systems with variable dead-time is calculated using methods of statistical analysis. The general results obtained are used to study the output distribution for spectrum shapes that are frequently involved in nuclear physics experiments. (auth)

15884 COUNTING-LOSSES INTRODUCED BY THE CASCADE CONNECTION OF TWO PARALYZABLE-COUNTERS. I. De Lotto (CNR-CISE, Milan) and P. F. Manfredi. Energia Nucl. (Milan), 12: 102-3(Feb. 1965).

The counting losses introduced by the cascade connection of two paralyzable dead-time counters are calculated, together with the mean time-spacing between two output events. (D.C.W.)

15885 SOME LONG-FOCUSING "DEPTH-INDEPENDENT" COLLIMATORS FOR IN-VIVO RADIOISOTOPE SCANNING. M. J. Myers and J. R. Mallard (Hammersmith Hospital, London). Intern. J. Appl. Radiation Isotopes, 15: 725-39(Dec. 1964).

Experimental results are given showing the dependence of the lateral resolution on the length of the collimator and the diameter of the holes at the top of the collimator; it is shown that the loss of point source lateral resolution for localization purposes is not as serious as might be expected. Experimental results are also given showing the dependence of the longitudinal or depth response on the length of the collimator and the effect of scattering material. Other design parameters are discussed including septa thickness. The performance of three different collimators of this type with plane sources were compared using a figure of merit and performance data is given for a counter using multi-crystals, one at the end of each channel of the collimator. With the multi-crystal system it is more difficult to arrange interchangeable collimators for different purposes but there is a low room background. The data presented enable convergent multichannel collimators to be designed to a given specification. Particular attention is paid to, and experimental results presented for, the performance of collimators that have 70% isocount lines extending to a depth of 17 cm from the collimator face in tissue and 50% resolution diameters of approximately 2 cm. (P.C.H.)

15886 A PROPORTIONAL COUNTER FILLED WITH A MIXTURE OF XENON AND ISOPENTANE. G. E. Kocharov, V. O. Naydenov, and V. M. Shuvaev (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1725-7(Oct. 1964). (In Russian)

The coefficients K and U that characterize a gas, according to the theory of proportional counters were measured for a xenon–isopentane mixture by the method of Kocharov and Korolev. A 27.4-cm long counter with a 4.6 cm diameter cathode and a 50 micron diameter anode containing xenon at 650 mm Hg and isopentane at 10 mm Hg was employed with 5.07-Mev α-particles and 30.6 and 41.9-kev gamma rays. The values of K and U were found to be 64.5 v/cm mm Hg and 23 v, respectively. It follows from these data that the cross section of xenon for ionization by electrons is 3.2×10^{-16} cm^2. Pontecorvo showed that the energy resolution of a proportional counter is reduced by space-charge effects when the gas amplification exceeds a certain critical value, and that the product of this critical amplification and the energy released in the working volume of the counter is constant. Working with x rays, Pontecorvo found this product to be 3×10^8 ev. This product was measured with 5.07 Mev alpha-particles and 30.6 kev gamma-rays and was found to be 1.7×10^8 and 1.5×10^8 ev in the two respective cases. The reduction in energy resolution when the critical amplification is exceeded is illustrated with ^{133}Ba gamma spectra recorded at anode potentials of 1.9 and 2.0 kv. The gamma spectrum of ^{133}Ba was recorded at energies from 30 to 80 kev. Three lines were observed at 30.6, approximately 50, and 78.6 kev. From the relative intensities and known internal conversion coefficients, it is concluded that the L to K capture ratio is 1.1. This is in good agreement with the finding of Gupta, Iha, Joshi and Madan and in disagreement with the result of Langevin. (ATD)

15887 MEASUREMENTS OF NEUTRON SPECTRA BY MEANS OF SINGLE-CRYSTAL SPECTROMETER WITH THERMAL COLUMN. S. V. Starodubtsev, B. I. Khrushchev, V. A. Belyakov, and V. E. Komarov (Inst. of Nuclear Physics, Academy of Sciences, USSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 37-40(1964). (In Russian)

A method suitable for investigating the spectra of thermal neutrons with wavelengths from 1.0 to 5.3Å is described. Reflection from the (111) plane of monocrystalline lead is used to analyze the neutron beam. (ATD)

15888 LIQUID SCINTILLATOR FOR MEASURING ABSORPTION DOSES OF NUCLEAR RADIATION IN MIXED REACTOR FIELDS. S. V. Starodubtsev, M. N. Gurskii, and A. N. Tsoi (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 75-6(1964). (In Russian)

The possibility of detecting radiochemical changes by means of scintillation radiometry was investigated. p-terphenyl was chosen as best fulfilling the conditions necessary for the detection of mixed gamma-neutron radiation.

Determination of the absorbed dosage was accomplished by measuring the light output of the exposed sample in toluene. The scintillation apparatus consisted of a model FEU-29 photoelectric multiplier supplied by a model VS-16 high-voltage stabilizer. The output of the FEU-29 went to a wide-band amplifier model USh-2. p-terphenyl samples were irradiated with gamma rays alone and with mixed gamma-neutron radiation. The light output of gamma-irradiated p-terphenyl was found to be constant in the range of absorbed dosage from 6×10^6 to 2×10^8 rad. In the mixed gamma-neutron radiation of a reactor, there was a linear decrease in the light output in the same interval. It was determined that about 55% of the total absorbed energy was from fast neutrons. The system described is considered to be suitable for use as a dosimeter for the mixed radiation from a nuclear reactor. (ATD)

15889 HIGH-ENERGY GAMMA-RAY DOSIMETRY: EXPERIMENTAL MEASUREMENTS AT A NUCLEAR POWER STATION. P. D. Holt and J. A. B. Gibson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Energy: Pt. A and B, 19: 17-31(Jan. 1965). (AERE-R-4451)

The gamma dose rate and the variation of dose-rate spectrum were determined at the Chapelcross reactor station. The dose rate was measured with survey instruments and personal dosimeters, (film dosimeters and quartz-fibre electroscopes). The spectrum was determined with gamma spectrometers using sodium iodide (thallium-activated) crystals in conjunction with multichannel analyzers and portable single-channel analyzers. The measurement of the dose-rate spectrum and determination of the proportion of the radiation above 5 Mev enables the response of various instruments and dosimeters to be assessed for use around nuclear power stations. The results of the measurements show that the unscattered fraction of high-energy radiation (>5 Mev) was responsible for from 20 to 60% of the total dose. The survey instruments using Geiger-Müller counters as detectors gave an enhanced reading at all dose rates and could be corrected directly. The film dosimeters also gave results which were 50% too high, but the results from the AERE/RPS plastic film dosimeter could be corrected approximately by measuring the ratio of the dose rates under two filters. The resulting error was about 10%. (auth)

15890 DETECTION LIMIT AND PRECISION IN PHOTOGRAPHIC DOSIMETRY. Kazuyoshi Bingo and Ichiro Miyanaga (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 24-8(Jan. 1965).

The detection limit and precision of dose estimation by photographic dosimetry were statistically analyzed. The detection limit of Fuji film badge was found to be 9 mr for Ra γ radiation, and stack densitometry with three films lowered the limit to 5.6 mr. It was found that the precision of dose estimation below 30 mr was mainly dependent on the variances of the film background density. Latent image fading was found to cause no change in the standard deviation of the optical density. Accordingly, the effect of fading on the detection limit and the precision of dose estimation could be treated as if the sensitivity of the film was reduced by a factor equal that of the fading. The relationship of the detection limit to the standard deviation of the background density and to the film sensitivity is discussed. The ratio of the background density standard deviation to the film sensitivity was found to be closely related with the detection limit of the film. The probability of detecting a positive dose beyond the variance of the background density was calculated for the case where the film was replaced every 3 months. Ten milliroentgen of γ exposure could be detected in every film at a confidence level of 95%. (auth)

15891 A SCINTILLATION COUNTER TELESCOPE FOR STUDY OF THE (n,p) AND (n,d) REACTIONS. K. Debertin, K. Hofmann, and E. Roessle (Johann-Wolfgang-Goethe-Universitat, Frankfurt am Main). Nucl. Instr. Methods, 33: 1-8(Mar. 1, 1965). (In German)

The telescope described consists of a CsI(Tl) and two gaseous scintillation counters. Protons and deuterons are discriminated by registering E- and dE/dx-pulses simultaneously. The telescope was successfully used in the investigation of (n,p)- and (n,d)-reactions at neutron energies from 6 to 22 Mev. (auth)

15892 ON THE EFFICIENCY OF THE MULTIPLE WIRE-CAVITY SPARK COUNTER FOR FAST NEUTRON DETECTION. G. Singh and N. K. Saha (Univ. of Delhi). Nucl. Instr. Methods, 33: 9-12(Mar. 1, 1965).

Studies were made on the detection efficiency of the multiple wire-cavity spark counter for fast neutrons. Counting characteristics were taken by operating the counter in air and in nitrogen at various pressures ranging from 70 to 150 cm Hg. In both cases the plateau counting rate increases with pressure to a flat maximum at about 120 cm Hg, followed by a rapid fall. Under identical conditions, the counting rate is found to be 13 times higher in nitrogen than in air. Qualitative explanation of the observations is given. (auth)

15893 A VERSATILE n-He^3 COINCIDENCE SYSTEM WITH IMPROVED He^3 RESOLUTION. R. A. I. Bell, N. G. Chapman, and P. B. Johnson (Victoria Univ. of Wellington, N. Z.). Nucl. Instr. Methods, 33: 13-18(Mar. 1, 1965).

A versatile n-He^3 coincidence system for use with the $D(d,n)^3He$ reaction is described. The use of a silicon surface barrier detector, with a thin nickel foil window has enabled complete resolution of the ^3He peak with consequent improved neutron flux determination. The angular distribution of the neutron beam tagged by the associated particle technique was investigated using a plastic scintillator as the neutron detector. This distribution is compared with the calculated angular spread of neutrons from a thick target. (auth)

15894 SPECTROMETER FOR CHARGED PARTICLES EMITTED IN REACTIONS WITH FAST NEUTRONS. V. K. Voitovetskii, I. L. Korsunskii, A. I. Novikov, Yu. F. Pazhin, and R. S. Silakov (Kurchatov Atomic Energy Inst., Moscow). Nucl. Instr. Methods, 33: 19-28(Mar. 1, 1965).

A description and main characteristics are given of an experimental arrangement with a scintillation spectrometer for measuring the energy and angular distributions of charged particles emitted in fast neutron reactions. Deuterons and protons are completely separated in the spectrometer, as is necessary in measurements of this kind. (auth)

15895 ABSOLUTE MEASUREMENT OF RADIOACTIVE SOURCE STRENGTHS BY A GENERAL COINCIDENCE METHOD; INFLUENCE OF DIRECTIONAL CORRELATION, SCATTERING COINCIDENCES, AND SUM-EVENT-PULSES. E. Kowalski (Universitat, Bern). Nucl. Instr. Methods, 33: 29-38(Mar. 1, 1965). (In German)

By means of a general form of the coincidence method according to Meyer et al. it is possible to measure absolute radioactive source strengths of isotopes with high precision for large classes of decay schemes and different kinds of radiations emitted, without the counter responses and solid angles being known with a corresponding accuracy. Owing to the required radiation detectors with relatively small solid angles the angular correlation between both coinciding radiations must be regarded. An attempt is made to show up the general conditions, for which it is possible to eliminate the effect of non-disturbed angular correlation on the result of the measurements without knowing the correlation function by taking a proper average value of measurements at various angles between the symmetry-axes of both detectors. Furthermore the effect of coincidences by scattering and so-called sum-event-pulses on the result will be discussed using a generalized method for describing the counter responses. Sum-event-pulses result from simultaneous recording of both coinciding radiations in the same detector. (auth)

15896 A TEMPORARY PULSE-STORAGE UNIT. H. Arque Almaraz (Univ. of California, Berkeley). Nucl. Instr. Methods, 33: 61-7(Mar. 1, 1965). (UCRL-11539)

A temporary pulse-storage unit (stretcher) was developed and built. The unit is capable of storing and reshaping individual pulses. The voltage drop of the stored pulse in the stretcher is less than one channel for storage periods

up to 10 msec. A description of the unit, which utilizes a capacitor-type storage device, electronic switches, and conventional timing circuits, is given. Considerations on timings and circuit components are also given. Applications in a pulse-derandomizer system and a multiparameter recording system are mentioned. Energy resolutions better than 0.1% are reported for systems that use the stretcher. (auth)

15897 AN ANTICOINCIDENCE SHIELDED-MULTIDIMENSIONAL GAMMA-RAY SPECTROMETER. R. W. Perkins (General Electric Co., Richland, Wash.). Nucl. Instr. Methods, 33: 71-6(Mar. 1, 1965). (HW-SA-3726)

A three crystal detector system was fabricated and evaluated in conjunction with a 4096 channel multiparameter analyzer for multidimensional gamma spectrometry. The detector system consists of two 4 inch thick by 6 inch diameter NaI(Tl) crystals which are contained in the center hole of an annular NaI(Tl) crystal of 11½ inches diameter by 12 inches thick. The spectrometer utilizes the gamma decay characteristics of each radionuclide for its identification and measurement by viewing the sample with two detectors and cancelling those events not totally absorbed in these principal detectors with a third detector which serves as an anticoincidence annulus. Coincidence counts are stored according to the photon energies responsible for the event in the energy-energy plane of the memory while non-coincidence events are stored in the normal manner. For triple coincidence spectrometry the three detectors view the source and the coincidence spectrum of any two can be recorded while the third detector serves as the coincidence monitor. Measurements of the system's counting efficiency, and of factors affecting its background, Compton and backscatter response are discussed along with some applications of the instrument. (auth)

15898 A BETA SPECTROMETER USING SOLID STATE DETECTORS. J. Reynolds and B. Persson (Univ. of Lund, Sweden). Nucl. Instr. Methods, 33: 77-83(Mar. 1, 1965).

The construction and operation of a surface-barrier solid state beta spectrometer of approximately 4π aperture is described. Its properties were investigated by the use of electrons from internal conversion and beta decay. Corrections to the spectra measured are small, and methods for their evaluation are given. (auth)

15899 AN ANALYTICAL METHOD OF ANALYSING GAMMA-RAY PULSE HEIGHT SPECTRA. P. Subrahmanyam and P. Ammiraju (Tata Inst. of Fundamental Research, Bombay). Nucl. Instr. Methods, 33: 87-92(Mar. 1, 1965).

An analytical method for the conversion of count rate distribution due to gamma rays to the true incident photon spectrum by means of a sensitivity matrix was discussed. The method of determining the sensitivity matrix by using radioactive gamma ray sources and its correctness regarding intensity and energy reproduction for various gamma ray spectra is described. The limitations of the method are discussed. (auth)

15900 A METHOD OF CORRECTING FOR "MISSED" RESONANCES IN NEUTRON SPECTROSCOPY. T. Fuketa and J. A. Harvey (Oak Ridge National Lab., Tenn.). Nucl. Instr. Methods, 33: 107-13(Mar. 1, 1965).

A method is described of obtaining the corrected s-wave strength function and the corrected average spacing of s-wave resonances from the observed resonance parameters from low energy neutron cross section measurements. The method of correcting for missed resonances is based on the Porter-Thomas distribution of the reduced neutron widths. Several graphical illustrations from the results of an iterative calculation by a digital computer are presented to give a general idea of the nature and numerical significance of the corrections. Finally, a set of master curves is given, from which one can estimate the correction factors using simple algebraic calculations for various experimental conditions. (auth)

15901 FAST MULTICHANNEL NEUTRON COUNTING SYSTEM. G. Palmieri and G. Ricco (Istituto Nazionale di Fisica Nucleare, Genoa). Nucl. Instr. Methods, 33: 120-4(Mar. 1, 1965).

An almost constant efficiency neutron counter in the energy range 0–50 Mev and the associated multichannel pulse group analyzer is described. Possible measurements with this counting system are suggested. (auth)

15902 CARBON RECOIL DETECTION AND THE RESPONSE OF ORGANIC SCINTILLATORS IN $C^{12}(n,n)C^{12}$ SCATTERING. M. F. Steuer and B. E. Wenzel (Univ. of Georgia, Athens). Nucl. Instr. Methods, 33: 131-5 (Mar. 1, 1965).

Recoiling carbon nuclei produced by neutron scattering from the carbon in NE102 and NE213 organic scintillators were detected by fast coincidence techniques and their pulse spectra used to measure the scintillators' responses relative to electrons. A system which employs carbon recoil detection in neutron polarization measurements is described. The method provides for discrimination against contributions from plural scattering. (auth)

15903 OPTIMIZATION OF MAGNET TRAJECTORIES IN ANALYSIS OF SPARK CHAMBER DATA. B. Zacharov (CERN, Geneva). Nucl. Instr. Methods, 33: 136-40(Mar. 1, 1965).

The problem of finding the best values of momentum and spatial parameters for particle trajectories is considered for the case where measurements are available only for the linear incident and emergent tracks. An iterative method is described for the trajectory fit and relevant expressions for the successive approximations and for the starting values are given. Derivation of the magnetic field in terms of known experimental measurements is discussed. Two cases are considered in detail, one for rectangular-aperture magnets with two symmetry planes and the other for narrow rectangular-aperture magnets with three symmetry planes. (auth)

15904 MAGNETOSTRICTIVE READOUT FOR "WIRE SPARK CHAMBERS." V. Perez-Mendez and J. M. Pfab (Univ. of California, Berkeley). Nucl. Instr. Methods, 33: 141-6(Mar. 1, 1965). (UCRL-11620(Rev.1))

A method for locating track coordinates in a wire spark chamber is described. The transducer is a nickel magnetostrictive ribbon which is coupled to the chamber wires magnetically. Spark coordinates are determined by digitizing the time delay from the chamber trigger signal to the arrival of the magnetostrictive pulse at a pickup coil. Multiplespark events are readily recorded without ambiguities; the only limitations are the two-spark resolution of the transducer signal and the readout capacity of the digitizing electronics. (auth)

15905 DIRECTIONAL GAMMA RAY DETECTOR FOR MEASURING HIGH ENERGY GAMMA RAYS FROM STARS. D. Sadeh (Atomic Energy Commission, Yavne, Israel). Nucl. Instr. Methods, 33: 147-50(Mar. 1, 1965).

A new directional gamma ray detector is described, based on the use of an array of narrow cylindrical plastic scintillators and a single photomultiplier. When a high energy gamma ray impinges upon the scintillator an electron-positron pair is emitted in the direction of the primary gamma ray. If this gamma ray was moving in the direction of the axis of the scintillator the energy dissipated in the scintillator will be greater than if the path made an angle with the axis. Thus, with a simple electronic bias on the output of the photomultiplier it is possible to record only pulses higher than a certain threshold. The scintillator serves both to convert the gamma rays to electron-positron pairs and to detect the latter. The scintillators are fitted into holes in Perspex, this material serving to transmit the light produced to the photomultiplier. It also serves as an absorber of electrons and prevents transverse electrons from traversing more than one crystal. The angular resolution obtained with 18-Mev gamma rays was 6° half angle, but with 50-Mev gamma rays and 3 mm × 20 cm plastic scintillators a half angle of 1.5° can be achieved with a 20% efficiency. Such a telescope can be mounted on a satellite to find if any stellar object emits high energy gamma rays. (auth)

15906 A SIMPLE WAY TO GET A PARABOLIC ENERGY RESPONSE IN A GREY WEDGE GAMMA-SPECTROMETER. H. Grueter (Universitat, Munster, Ger.). Nucl. Instr. Methods, 33: 159-60(Mar. 1, 1965).

A method to produce a nonlinear energy scale in a grey wedge analyzer is outlined. A double controlled tube in a cathode follower circuit is used. (C.E.S.)

15907 NANOSECOND LIFETIME MEASUREMENTS WITH A FAST GASEOUS COUNTER. A. Krusche, D. Bloess, and F. Muennich (Technische Hochschule, Brunswick). Nucl. Instr. Methods, 33: 169-71(Mar. 1, 1965).

Lifetime measurements of low-lying nuclear states are rendered difficult since the time resolution of a scintillation counter decreases with decreasing energy of the incident photon or electron. Aspects of a fast gas-filled counter, which is especially well suited for such measurements, are discussed. Its main advantage lies in the fact that the internal time resolution is in principle independent of the energy of an ionizing particle, but depends only on the geometry of the counter. (C.E.S.)

15908 A GASFLOW COUNTER WITH VARIABLE SENSITIVE AREA FOR LOW-LEVEL BETA COUNTING. H. Erbe (Telefunken AG, Ulm, Ger.). Nucl. Instr. Methods, 33: 172-3(Mar. 1, 1965).

An endwindow gas-flow counter with a variable sensitive area was developed to overcome the difficulties associated with the changing counters. The sensitive volume of the counter may be varied by interchanging two cables only. The performance of the counter for beta particles is briefly discussed. (C.E.S.)

15909 THE DEPLETION DEPTH OF LITHIUM-ION DRIFT DETECTORS AS A FUNCTION OF THE TIME, VOLTAGE AND THE DIFFUSION COEFFICIENT. J. Takacs (Oxford Univ.). Nucl. Instr. Methods, 33: 174-5 (Mar. 1, 1965).

The depletion depth (w) of lithium-ion drift detectors was calculated from the equation $w = [2\mu Vt/kT]$, where μ is the mobility, V is the drifting voltage, and t is the time. The mobility and the diffusion coefficient D are connected by Einstein's relation $D = (kT/e)\mu$. The results of the calculations are presented in the form of nomographs from which the depletion depth as a function of time can be read for different drift voltages and temperatures. (C.E.S.)

15910 REGISTRATION OF CHARGED PARTICLES EMERGING IN GAS OF A SPARK CHAMBER WITH LARGE GAP BETWEEN THE ELECTRODES. Yu. V. Galaktinnov, V. A. Lyubimov, and F. A. Pavlovskii (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Instr. Methods, 33: 176-7(Mar. 1, 1965).

A spark chamber with a 15-cm gap between the electrodes was used. The chamber was filled with neon to a pressure of 760 torr and worked in the regime of ionization measurement. The events of hyperon (Λ) and meson (K) decay in flight were used to produce particles in the volume of the chamber. Particle track luminosities are discussed. (C.E.S.)

15911 OPERATION OF A SONIC SPARK-CHAMBER SYSTEM. E. Lillethun, B. Maglic, G. Manning, C. A. Strahlbrandt, A. E. Taylor, and T. G. Walker (CERN, Geneva). Nuovo Cimento (1), 2: Suppl., 310-35(1964).

Results are presented of a study of the feasibility of using sonic spark chambers in high-energy experiments. The tests were made with a system designed to measure the angular and momentum distributions of protons elastically and inelastically scattered by hydrogen. The large solid angle of the spark chambers together with the improved spatial resolution compared with a scintillation counter system was of particular advantage in this application. The use of the sonic method for location of sparks rather than the photographic method permitted the immediate digitization of the information and thus reduced the time needed for data analysis. (C.E.S.)

15912 PERSONAL EXPERIMENTAL DATA IN THERMOLUMINESCENT DOSIMETRY. R. Renzi (Università, Florence). Nuntius Radiol., 30: 490-9(June 1964). (In Italian)

The theoretical basis of thermoluminescence dosimetry is described, and some experimental data concerning the calibration energy dependence, dose dependence, and resolution of this dosimetric system are presented. (auth)

15913 THE RESPONSE OF X-RAY FILMS TO INDIUM-116 BETA PARTICLES FROM NEUTRON ACTIVATED INDIUM FOILS. Arnold W. Schultz (Army Materials Research Agency, Watertown, Mass.). Photo. Sci. Eng., 9: 62-6(Jan.-Feb. 1965).

To meet needs in neutron radiography studies, the characteristic curves, relative speeds intensification factors, and image unsharpnesses were determined for some x-ray film. The density ranges considered were 1.0 to 2.5 for the combination film with fluorescent intensifying screens and 0.3 to 3.0 for the films alone, for exposure to diffuse beta radiation from 54-min ^{116}In. The beta characteristic curve shapes were in good agreement with curve shapes reported using x rays, while the film-screen combinations had curve shapes that differed. (auth)

15914 EVIDENCE FOR POSITRON-ELECTRON DIFFERENCES IN SCINTILLATION RESPONSE AND STOPPING POWER. Takio Tomimasu (Electrotechnical Lab., Tokyo). Phys. Rev., 138: A268-72(Apr. 5, 1965).

Positron-electron differences in scintillation response and stopping power of NaI(Tl) crystal were studied using a two-crystal NaI(Tl) scintillation spectrometer. The scintillation response of the crystal to positron-electron pairs induced by gamma rays in the crystal was accurately measured. The energy distributions of positrons and of electrons induced in the crystal were calculated according to the formula of Nishina et al. In order to make clear the difference in scintillation responses to positrons and to electrons, gamma spectra were also measured by use of the same device. The scintillation response to positrons was obtained from the experimental response to positron-electron pairs and to electrons. The positron-electron difference in stopping power predicted by Rohrlich and Carlson was confirmed with the experiment. Although fairly good agreement with the theory can be seen at energies above 150 kev, the experimental positron-electron difference in stopping power in the lower energy range deviates from the theory to some extent. (auth)

15915 CONVERSION OF THE BAUSCH AND LOMB DUAL GRATING SPECTROGRAPH FOR THE DIRECT READING OF NONUNIFORM LINE PROFILES. Clifford J. Cremers (Georgia Inst. of Tech., Atlanta). Rev. Sci. Instr., 36: 314-16(Mar. 1965).

A description is given for the modification of the Bausch & Lomb dual-grating spectrograph so that it may be used to directly measure longitudinal spectral line profiles with fixed phototube detectors. These measurements are often necessary in plasma diagnostics. The modified instrument has a single, compact, out of the way drive system that tilts the grating. This allows any number of lines to be recorded simultaneously. The time for scanning a cross section in the radiating source is on the order of 30 sec. (auth)

15916 HIGH EFFICIENCY, LOW BACKGROUND GM COUNTER. V. J. Landis and R. C. Jensen (San Diego State Coll., Calif.). Rev. Sci. Instr., 36: 323-5(Mar. 1965).

A gas flow, G-M counter having a low background, a 4π counting configuration, and a convenient sample changing arrangement was constructed and tested. The counter consists of two disk-shaped detectors hinged so that the sample is completely enclosed by the detector windows. The beta counting efficiency is about 94% for a weightless sample. The counting characteristics, stability, and configurational efficiency are comparable to conventional designs. The relative figure of merit of the counter is such that, within a given time period, two to four times as many samples can be counted to the same statistical accuracy as was possible with 2π type counters. (auth)

15917 DRIFT-FREE MÖSSBAUER SPECTROMETER. F. C. Ruegg, J. J. Spijkerman, and J. R. DeVoe (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr., 36: 356-9(Mar. 1965).

In order to eliminate drifts encountered in electromechanical Mössbauer spectrometers, a drive was developed which is drift free with regard to velocity as well as position. The spectrometer can be driven in two modes: constant acceleration input signal is the analog output of the address scalers of a multichannel analyzer running as a multiscaler (time mode). The constant velocity is obtained from a photocell slit system which drives the input of the spectrometer with a rectangular wave. In both modes, the photocell system is used to eliminate all position drifts by starting each new cycle from the same position. To analyze the velocity of the spectrometer a voltage-to-frequency converter and multichannel analyzer are used. (auth)

15918 LORENTZ FORCE CALIBRATOR FOR MAGNETOGASDYNAMIC INTERACTION COILS. P. Savic and V. Guty (National Research Council of Canada, Ottawa). Rev. Sci. Instr., 36: 373-4(Mar. 1965).

A device is described which measures the Lorentz force of any magnet coil with radial fringe component due to the axial motion of a metallic slug. The first method uses the effect of this force on the logarithmic decrement of a mass-spring system in the second method a feedback circuit effects self-excited oscillations, the Lorentz force being measured by its effect on the loop gain necessary to maintain a given oscillation amplitude. (auth)

15919 LOW ENERGY CHARGED-PARTICLE DETECTION USING THE CONTINUOUS-CHANNEL ELECTRON MULTIPLIER. D. S. Evans (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instr., 36: 375-82(Mar. 1965).

It was found to be possible to operate the continuous-channel electron multiplier, a recently developed type of windowless electron multiplier, in a gain-saturated mode such that single, charged particles entering the input mouth of the channel will initiate output pulses whose amplitude and shape are both uniform and independent of the character of the excitation radiation. By suitable design of the channel this saturated pulse can be made stable against changes in such operating conditions as ambient pressure and applied voltage. When operated in this mode, the efficiency of the channel for the detection of electrons over the energy range 250 ev to 10 kev is estimated to be greater than 50%. (auth)

15920 BACKGROUND EVENTS IN PHOTOMULTIPLIER TUBES AT HIGH ALTITUDES. G. Chodil (Univ. of California, Livermore), David Hearn, R. C. Jopson, Hans Mark, C. D. Swift, and K. A. Anderson. Rev. Sci. Instr., 36: 394-5(Mar. 1965).

The contribution of luminescence and Cherenkov radiation produced by charged particles in the glass of the photomultiplier and the NaI crystal holder to the tube noise background was investigated by flying an NaI crystal assembly without the crystal on a balloon with the photocathode face up. (D.C.W.)

15921 SOLARIZATION WITH GAMMA-RAYS AND ELECTRONS. [PART] I. Akio Miyauchi and Yasuo Shimizu. Sci. Publ. Fuji Photo Film Co., Ltd., No. 7, 9-11[(1958-59)(1961)]. (In Japanese)

Gamma rays from ^{137}Cs and ^{60}Co and the electron beam of an electron microscope were used to examine the solarization of an x-ray film due to those rays. Observations of Ehrlich that the solarization increases as the x-ray exposure rate decreases were confirmed for gamma-ray and electron-beam exposures. For the gamma-ray exposures, it was observed that there exists an optimum exposure rate at which the strongest solarization occurs, and that the degree of solarization decreases when the gamma exposure rate becomes higher or lower than the optimum rate. (auth)

15922 SOLARIZATION WITH GAMMA-RAYS AND ELECTRONS. [PART] II. Akio Miyauchi and Yasuo Shimizu. Sci. Publ. Fuji Photo Film Co., Ltd., No. 7, 12-17[(1958-59)(1961)]. (In Japanese)

It was found experimentally that in electron-beam exposures carried out in vacuum, shapes of the high-intensity reciprocity failure curves in the reversal region for these exposures are similar to those for gamma-ray exposures in air, and that when film strips are exposed to gamma-rays after bathing in aqueous solutions of $NaNO_2$ or CH_3COOH, the reciprocity failure curves shift to the high-exposure side along the exposure-time constant axis. (auth)

15923 X-RAY ELEMENTS FOR DOSIMETRY. Harald F. H. Warrikhoff (Max-Planck-Gesellschaft, Berlin). Z. Angew. Phys., 18: 44-53(Nov. 5, 1964). (In German)

It is shown that the geometrical–limited sensitivity of dosimeters is dependent only on the enclosed volume, and that a subdivision of the space with more electrode pairs yields no advantage for potential measurement. Therefore, single cylindrical x-ray elements with a vacuum insulator were theoretically investigated. Calculations were made for the mantle element, with an outer heavy metal surrounding a light metal, and for the rod element, with an inner heavy metal electrode. The calculated sensitivity is in satisfactory agreement with experimental results and thus shows that the simplifications in the theoretical treatment are valid. (L.B.S.)

15924 YADERNOI PRIBOROSTROENIE NAUCHNO-TEKHNICHESKII SBORNIK. VYPUSK 1. (Nuclear Instrumentation). L. S. Gorn, B. N. Kononov, and K. F. Kuznetsov, eds. Moscow, Atomizdat, 1964. 175p.

Seventeen articles are included on development, construction, and uses of various electronic devices. A theoretical analysis is made of new measuring methods and the design and schemes of multichannel pulse analyzers. Descriptions are given of new devices for improving metrical and operational efficiency of multichannel analyzers. (R.V.J.)

15925 APPLICATIONS OF TWO-DIMENSIONAL ELECTRIC AND MAGNETIC FIELDS IN THE ANALYSIS OF CHARGED PARTICLE MASS AND ENERGY. V. M. Kel'man (Ioffe Inst. of Physics and Tech., Leningrad). p.113-24 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963. (In Russian)

Problems encountered in mass spectrometry are analyzed, and descriptions are given of electrostatic and magnetic prisms which are not limited by deficiencies present in mass spectrometers. Descriptions are also given of electrostatic beta and mass spectrometers and of a variation of beta spectrometer with a magnetic prism. (tr-auth)

15926 A LEAD SLOWING-DOWN-TIME SPECTROMETER. K. Chandramoleshwar, M. P. Navalkar, R. Ramanna, D. V. S. Ramakrishna, and K. R. Subbaramu (Atomic Energy Establishment, Trombay, India). p.159-63 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Expressions are obtained for dispersion, slowing-down density, and number of counts in a 1/v-efficiency detector, for a burst of fast neutrons diffusing in a thermalizing medium. The lead chamber, neutron source, and neutron BF_3 proportional counter are described. Results are reported of transmission experiments using the bare counter and the counter covered by Ag and In, and of measurements of the relative fission cross sections of ^{235}U and ^{239}Pu as a function of energy to determine the Pu content of samples. (M.J.T.)

15927 GLASS SCINTILLATORS FOR NEUTRON DETECTION. K. K. Devgan (Atomic Energy Establishment, Trombay, India). p.164-8 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The preparation of clear and colorless glass scintillators of Li-Mg-Al-silicate and B-Na-Al-silicate systems activated with cerium ion as a fluorescent center is described. The response of the scintillators to slow neutrons is shown, and their merits are discussed. (M.J.T.)

15928 A SIMPLE SINGLE-CHANNEL PULSE-HEIGHT ANALYZER FOR A WIDE RANGE OF INPUT PULSE DURATIONS. K. Gopalan (Indian Inst. of Science, Bangalore, India). p.178-81 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

An analyzer that can handle input pulses from about 1 to more than 1000 μsec duration without readjustment, with a simple operation and circuitry, is described. The block diagram is given, and the operation of the analyzer is discussed. (M.J.T.)

15929 FURTHER MODIFICATIONS OF THE THIN LENS BETA-RAY SPECTROMETER AND CONVERSION ELECTRON SPECTRUM OF In^{113}. R. P. Chaturvedi (Panjab Univ., Chandigarh, India) and K. C. Mann. p.233-42 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The design of an improved thin-lens beta spectrometer is given; the spectrometer was modified to allow a variable source-to-detector distance and to provide an arrangement for making source-detector and magnetic axis in exact coincidence. The internal conversion spectrum of ^{125}Sb, investigated with this spectrometer, is presented. The electron-capture decay and the conversion spectrum of ^{113}Sn were also measured. (M.J.T.)

15930 PERFORMANCE OF THE DOUBLE-FOCUSING β-RAY SPECTROMETER. H. G. Devare and S. R. Amtey (Tata Inst. of Fundamental Research, Bombay). p.317-20 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The block diagram of the power supply for the spectrometer coils is shown, and the operation is described. The rotating coil method for continuously sensing and correcting the spectrometer field is illustrated and discussed. The performance of the spectrometer for various baffle settings is presented. (M.J.T.)

15931 A NEW METHOD IN NEUTRON SPECTROMETRY. P. K. Iyengar (Atomic Energy Establishment, Trombay, India). p.534-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Use of polycrystalline blocks containing only coherently scattering nuclei for filters in neutron spectrometry is reviewed. A device is described using two window filters like Be and BeO; the arrangement of the window filters is illustrated. The count rate of the set up as a function of neutron wavelength is given. Measurements of the inelastically scattered neutrons due to torsional oscillations of the ammonium ions in NH_4Cl using the normal single filter method and the window filter are compared. The use of the window filter for phonon studies is described, and diagrams are given of typical neutron groups due to phonons in Mg. (M.J.T.)

15932 AN EXPERIMENTAL MEASUREMENT OF SCINTILLATION CAMERA RESOLUTION AND ASSESSMENT OF PERFORMANCE. T. D. Cradduck and S. O. Fedoruk. 17p. (CONF-640611-6)

From Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Can.

The spatial resolution of a crystal-light pipe-photomultiplier combination was investigated, together with the linearity and sensitivity. The results show that the scintillation camera has no better resolution than a good radioisotope scanner. The sensitivity, however, is better. (D.C.W.)

15933 AUTOMATIC GAS PURGE SYSTEM FOR IONIZATION CHAMBER USED IN RADIOACTIVE SAMPLE ANALYSIS. Donald H. Frank (to Nuclear-Chicago Corp.). U. S. Patent 3,155,829. Nov. 3, 1964. Filed May 17, 1962.

An ionization gas chamber device for radiation detection and measurement includes a simple error-proof locking and opening means. Propagation of pulse signal data to electronic processing circuitry is automatically interrupted when the chamber is open. Then the chamber is closed a gas-purge cycle proceeds in proper sequence without manual adjustment to prepare the chamber for counting. A uniform gaseous atmosphere is thus maintained in the chamber during sample analysis. (A.G.W.)

15934 SELF-QUENCHING GAS-DISCHARGE NUCLEAR RADIATION COUNTER. G. B. Dashevskii. Russian Patent 164,081.

A self-quenching gas-discharge nuclear radiation counter is described. In order to reduce the scatter of volt-ampere characteristics and the effect of spurious capacitance shunting the filament of the anode, a resistor is connected between the effective part of the anode filament and anode contact. (OTS)

15935 HIGH-VACUUM GAS-DISCHARGE COUNTER FOR CHARGED PARTICLES AND GAMMA QUANTA. V. M. Kel'man and B. V. Bobykin. Russian Patent 165,844.

A high-vacuum gas-discharge counter for charged particles and gamma-quanta recording is described. In order to use this counter for recording gas-discharge radiation with electron oscillations in a Penning-type electric-magnetic field, the counter is made of negative disk-like electrodes with a positive cylindrical electrode placed between them; in addition, the electrodes are located between the magnetic poles. (OTS)

Radiation Effects

15936 (SC-R-64-1373) NEUTRON BOMBARDMENT REDUCTION OF TRANSISTOR CURRENT GAIN. C. A. Goben (Sandia Corp., Albuquerque, N. Mex.). Dec. 1964. Contract AT(29-1)-789. 96p. Dep.; $3.00(CFSTI).

Sandia Corp. Monograph.

An investigation was made of the role of emitter efficiency in the neutron-induced reduction of transistor current gain. The results show that: The emitter efficiency decreases with neutron flux and is responsible, along with base recombination, for the neutron degradation of the current gain. Changes in the base region parameters are similar to these in bulk material. The anomalous neutron-induced current component arises from the same type of recombination centers as the surface-perimeter current, and the neutron-induced recombination centers anneal at different rates in the bulk and space charge regions. (D.L.C.)

15937 PREDICTION OF TRANSISTOR RESPONSE TO PULSED IONIZING RADIATION. James P. Raymond (Northrop Corp., Ventura, Calif.). 27p. (CONF-617-18)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

A review is presented of work done on the prediction of transistor behavior in a transient radiation environment, using only electrical parameter measurements. One-dimensional analyses of the junction photocurrent and transistor behavior are discussed. The observed behavior of several transistor types is compared to the predicted behavior. (D.L.C.)

15938 EFFECTS OF FAST NEUTRONS ON HIGH FREQUENCY SILICON TRANSISTORS. D. K. Wilson and R. R. Blair. 14p. (CONF-617-17)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

The several processes involved in the degradation of transistor performance by fast neutrons are discussed for modern h-f Si planar transistors having low and medium power capabilities. High current ranges are also considered. The effects of the data on the design of transistors are considered, and it appears that a high-current radiation-resistant transistor is necessarily a rather low-voltage device, unless the transistor is of the pnpn type. (D.L.C.)

15939 MEANINGFUL TESTING FOR RADIATION EFFECTS IN SEMICONDUCTOR DEVICES. H. Schulman (Martin Co., Baltimore). New York, Institute of Electrical and Electronics Engineers, 1964, Paper No. 64-499, 10p, $1.00, (CONF-776-7)

From National Electronics Conference, Chicago, Oct. 1964.

The difficulties encountered in relating diverse radiation-experimental results, obtained in non-equivalent conditions, are considered. Included are questions relating to particle differences (e.g. neutrons, electrons, protons, and gammas), and, chiefly, the disparities in reactor neutron spectra. It was demonstrated that the use

of bulk semiconductor materials as damage monitors (as distinct from dosimeters) achieves the desired relationships directly. The necessity of relating changes in device characteristics to modifications in material parameters is motivated by these considerations. (auth)

15940 GAMMA IRRADIATION OF UNIJUNCTION TRANSISTORS. W. D. Rausch. 12p. (CONF-641009-7)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Eight unijunction transistors were irradiated in a ^{60}Co gamma irradiator to a dose of 4×10^7 rads carbon. The interbase resistance, modulated interbase current, emitter saturation voltage, intrinsic standoff ratio, and valley current were measured before, at selected intervals during, and after the irradiation. The reasons for the observed degradation in electrical characteristics are identified and explained. Good agreement was found between analytical predictions of radiation effects in unijunction transistors and the experimental results. (auth)

15941 PROTON AND ELECTRON PERMANENT DAMAGE IN SILICON SEMICONDUCTOR DEVICES. R. R. Brown (Boeing Co., Seattle). 27p. D2-90570; (CONF-641009-3)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Data are presented on permanent radiation damage in silicon diodes, p-n solar cells, and both n-p-n and p-n-p transistors. This information was accumulated from proton (2- and 10-Mev) and electron (2- and 5-Mev) irradiation tests. Selected transistors of the following constructions were tested: grown, diffused mesa, diffused planar, and epitaxial planar. Anomalous current gain degradation was observed for irradiated transistors operating at low currents. This damage was shown to be the result of ionization-induced changes in the surface recombination velocity. Transistor damage constants for displacement damage from proton and electron irradiation tests are compared with those found from neutron and gamma tests. (auth)

ISOTOPE TECHNOLOGY

General

15942 (ORNL-P-920) RADIOISOTOPE SHIPPING CONTAINER DEVELOPMENT. K. W. Haff (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 16p. (CONF-650103-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

Since the beginning of the radioisotope distribution program at Oak Ridge National Laboratory (ORNL) in 1946, more than 180,000 shipments containing ~2.2 million curies have been made without a single accident in which a significant release of radioactivity occurred. At present radioisotopes are shipped in containers which vary in size from a small cardboard box containing a liquid-filled bottle in a steel can to a large metal carrier shielded by 9 or 10 inches of lead. Although the safety record of radioisotope shipping is excellent, the trend to shipments containing a greater number of curies per package has necessitated more rigid packaging and shipping requirements. To meet these requirements, the Isotopes Development Center, at ORNL has initiated a program to evaluate existing shipping carrier designs and to develop methods to update these designs as economically as is possible. Wooden, fire, and impact shields and fire-protective paints have been investigated and found suitable as a means of meeting the higher requirements. Also being studied are gasket materials and design parameters of shipping casks which are adversely affected by fire and impact conditions. (auth)

Industrial Applications

Refer also to abstract 15109.

15943 (CONF-640909-10) RADIATION PRESERVATION OF FISH AND SHELLFISH OF THE NORTHEAST PACIFIC AND GULF OF MEXICO. John A. Dassow and David Miyauchi (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Oct. 19, 1964. 31p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From International Conference on Radiation Preservation of Foods, Boston.

The results of experimental work on the irradiation of king crab and Dungeness crab meats and petrale sole fillets have shown that the desired shelf-life extension of 4 weeks or more at 33°F (0.6°C) can be successfully obtained at the 0.2 megarad level. However, the radiation-pasteurized product gradually deteriorated in quality with time of refrigerated storage. Evidence of these changes was reflected in the decreases in sensory scores with increasing time of refrigerated storage. Some of these changes did not become a major factor in the deterioration of quality unless the storage life was extended beyond 4 weeks at 33°F (0.6°C). Results are reported from acceptability tests, microbiological studies, and chemical studies on irradiated and nonirradiated samples. (C.H.)

15944 (CONF-641002) RADIATION PASTEURIZATION OF FOODS. SUMMARIES OF ACCOMPLISHMENT PRESENTED AT FOURTH ANNUAL CONTRACTORS MEETING, OCTOBER 21-22, 1964. (Division of Isotopes Development (AEC), Washington, D. C. and Division of Biology and Medicine (AEC)). 216p. Dep.; $6.00(cy), 4(mn) CFSTI.

Separate abstracts were prepared on twenty-one sections of this report. Abstracts were previously prepared on five sections and appeared in NSA vol. 17 as numbers 25511 and 25514 and Vol. 18 as numbers 21817, 21825, and 21826. (C.H.)

For abstracts of individual sections see: 14933, 15014, 15945, 15946, 15947, 15948, 15949, 15950, 15951, 15952, 15953, 15954, 15955, 15956, 15957, 15958, 15959, 15960, 15961, 15962, and 15963.

15945 (CONF-641002(p.1-3)) IRRADIATION OF FRUITS AND VEGETABLES WITH MOBILE IRRADIATOR. John Harvey, Wm. Bramlage, Mel Couey, and Werner Lipton (Agricultural Research Service, Fresno, Calif. Market Quality Research Div.).

Twenty-two kinds of fruits and vegetables involving 42 varieties were irradiated at Fresno, Calif., with a mobile irradiator containing a 40,000 curie source of cobalt-60. The dose rate was about 5 kilorad per minute. Insofar as possible, the products were treated in the packages in which they were subsequently held. Holding was usually at simulated transit conditions. In addition, tomatoes and grapes were shipped as part of commercial shipments to New York, and oranges were shipped to Chicago and New York. Pasteurizing doses of gamma irradiation extended the market life of strawberries and of two of the three varieties of figs tested through reduction of decay without apparent impairment of fruit quality. Two-hundred krad was effective for strawberries, but usually 300 krad was needed for figs. Brown rot, but not Rhizopus rot, of peaches and nectarines was controlled; the peaches softened during irradiation and subsequently developed more red color, but less flavor than the controls. Radiation inhibited blue coloring of plums and increased softening of the fruits. Low doses inhibited ripening of pears by several days, but ripening was abnormal. Irradiated apples were softer, more shriveled, and had less flavor than the controls following storage for 3 to 6 months. Individual varieties of peaches and figs responded quite differently to radiation. Decay of grapes was controlled less effectively by radiation than by the customary sulfur dioxide fumigation. Irradiation caused undesirable softening of grapes and oranges and increased rind pitting of oranges. Avocados and olives were severely discolored both internally and externally by radiation. Radiation reduced postharvest growth, and inhibited opening of the caps of mushrooms. Sprouting of sweetpotatoes was inhibited by 8.25 krad during a subsequent 6 months' storage period. Sweetpotatoes were severely injured by exposure to 25 krad or more. Decay of cucumbers and cantaloupes was not consistently reduced by radiation. A dosage of 300 krad reduced decay of summer squash and caused a slight softening. Radiation caused softening, yellowing, and calyx discoloration of globe artichokes, severe spotting and discoloration of lettuce and endive, and accelerated denting of sweet corn. Radiation decreased decay in some lots of tomatoes, but increased mottling and softening. Radiation apparently increased the sensitivity of susceptible vegetables to chilling injury; irradiated sweetpotatoes, tomatoes, and peppers were injured more than the controls when held at chilling temperatures. (C.H.)

15946 (CONF-641002(p.4-7)) IRRADIATION OF POULTRY, WHEAT, AND SEEDS WITH MOBILE IRRADIATION. C. Golumbic, A. J. Mercuri, C. C. Fifield, and M. N. M. Kulik (Agricultural Research Service, Fresno, Calif. Market Quality Research Div.).

Fresh and frozen tray-packed cut-up fryer chickens were irradiated with a cobalt-60 source with 0.0, 0.1, 0.3, and 0.5 Mrads. Irradiation at the three levels conferred additional days of shelf-life on both fresh and frozen birds when they were subsequently stored at 34°F and at 40°F. Preliminary results are reported from studies of quality changes in stored, irradiated wheat. The wheat used was hard red winter, obtained in Kansas, and having a moisture content of 11.4 pct. and a protein content of 13.0 percent (14.0 pct. moisture basis). One lot was untreated (for use as a control), while five other lots of the same wheat were treated with dosages of 10, 25, 50, 125, and 175 thousand rads of gamma irradiation. These wheats were stored for 9 months at 75°F and were sampled for testing every three months. The final sampling period will be at the end of 1 year of storage. Results are included from studies to determine the relative effects of gamma radiation on the

germination and storage fungi of agricultural and vegetable seeds soon after exposure and after varying periods of storage. Three test series of corn, wheat, sorghum, Kentucky bluegrass, crimson clover, peanut, onion, and radish were used as follows: (1) Current year's crop seed inoculated with spores of Aspergillus amstelodami; (2) current year's crop seed not inoculated; and (3) older seed not inoculated. Samples were exposed to gamma radiation from a cobalt-60 source at the following doses (in Krads): 0, 5, 10, 20, 40, and 80. Seeds were tested for the presence of A. amstelodami, germination, and moisture content soon after irradiation, then stored at 21°C and several relative humidities. Data are presented on the minimum doses at which injury was observed. (C.H.)

15947 (CONF-641002(p.8-9)) RADIATION TREATMENT OF GRAIN AND GRAIN PRODUCTS. L. P. Henderson (Agricultural Research Service, Fresno, Calif. Market Quality Research Div.).

An extensive study was conducted to determine the gross affects of gamma radiation on the Indian-meal moth, Plodia interpunctella; the Angoumois grain moth, Sitotroga cerealella; the lesser grain borer, Rhyzopertha dominica, the confused flour beetle, Tribolium confusum; the rice weevil, Sitophilus oryzae; the cigarette beetle, Lasioderma serricorne; the black carpet beetle, Attagenus piceus; Trogoderma glabrum; and the grain mite, Acarus siro. Dosages included 13.2 kr, 17.5 kr, 25 kr, 45 kr, and 100 kr. Three of the species of beetles were also treated at a fractionated dosage of 13.2 kr ± 10 percent repeated 5 times at hourly intervals. All metamorphic stages of the test insects were used in tests. In all species of beetles, the adults were the most tolerant of radiation, followed by the pupae, then the larvae, while the eggs were the most susceptible. No dosage used was sufficiently high to produce immediate complete mortality of all species. Sterility occurred following gamma radiation of a single continuous dose of 25 kr or more. The results of the fractionated dosage indicate that the total effect is not cumulative. (C.H.)

15948 (CONF-641002(p.11-14)) REPORT OF APPLIED RADIATION RESEARCH AT GLOUCESTER, MASSACHUSETTS. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.).

Over 400 men engaged in taste tests could not tell the difference between irradiated 30-day-old haddock fillets that had been stored at 33°F and top quality fresh frozen haddock fillets. In general, the taste panel found little quality difference between air- and vacuum-packed samples of cod fillets, ocean perch, and pollock fillets irradiated with doses of 150,000; 250,000; 350,000; or 450,000 rads γ radiation and stored at 33°F. (C.H.)

15949 (CONF-641002(p.23-8)) RADIATION PASTEURIZATION OF GULF SHELLFISH. Arthur F. Novak (Louisiana State Univ., Baton Rouge. Dept. of Food and Science and Technology).

Field trials on public acceptance of γ irradiated shrimp were conducted in 4 coastal and inland cities. Panelists in all the tests preferred the irradiated shrimp to the non-irradiated control at storage periods of 15 to 25 days. The importance of the procedure employed for obtaining fresh shrimp, the method of handling and storing, and the time of holding prior to irradiation, are stressed. It is pointed out that the quality of fresh shrimp is not altered substantially by low-dose γ radiation and only products of high initial quality can be preserved successfully. Preliminary tests showed that shrimp stored in liquid N were superior to ice stored controls from the same catches on the same boat. Results are included from studies on radioinduced changes in enzymes involved in shrimp spoilage and the physiology of radioresistant bacteria in shrimp. Gamma radiation doses of 0.2 Mrad increased the refrigerated storage life of oysters from 16 to 20 days and greatly reduced the number of coliform bacteria in the oysters. (C.H.)

15950 (CONF-641002(p.29-31)) IRRADIATION PRESERVATION OF FRESH-WATER FISH. H. L. Seagran, J. A. Emerson, and N. Kazanas (Bureau of Commercial Fisheries, Ann Arbor, Mich.).

The application of gamma irradiation at substerilization doses in the extension of the refrigerated shelf life of fresh yellow perch fillets and smoked chub was investigated. Results indicated that both products are well suited to the process of irradiation-pasteurization. In the case of fresh yellow perch fillets, three storage tests were conducted at a holding temperature of 33°F., and two tests at 42°F. In each instance, the irradiation dose was 0.0, 0.3 and 0.6 megarad. The fillets were evaluated by sensory panel, chemical tests, and microbiological examination. Results of preliminary tests on the radiosensitivity of thiaminase showed that the activity of this enzyme can be reduced by gamma radiation. (C.H.)

15951 (CONF-641002(p.42-6)) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. E. C. Maxie and N. F. Sommer (California Univ., Davis).

Strawberries continue to show more promise for application of gamma radiation as a practical technology than any other fruit. When irradiated strawberries were inoculated with known numbers of Botrytis spores, no evidence was found for increased susceptibility to decay. This precludes the necessity for overwraps or sealed packages for irradiated berries. Tests with controlled atmospheres (high carbon dioxide–low oxygen) on Shasta strawberries indicated that 200 Krad was superior as a fungistatic agent. Tests for long-lived free radicals in irradiated strawberries were negative. Fruits of all varieties of freestone peaches tested withstood 200 Krad without adverse effects on the skins. Simulated transit tests revealed no major differences in flavor of unirradiated fruits. Evidence was obtained that bruises imposed upon the fruit prior to irradiation gave more severe symptoms than bruises of the same magnitude imposed after irradiation. Tests with Bartlett pears indicate that 1 to 4 hours in anaerobic conditions was as effective as 24 or more hours in protecting the fruits from adverse textural effects by gamma irradiation. Taste panel evaluation of fresh figs revealed no adverse effects of doses as high as 300 Krad. However, textural effects at doses above 200 Krad were considered deleterious to fruit quality. Taste panel evaluation of dried figs and prunes subjected to doses which permitted storage at room temperature for 6 weeks, revealed no unacceptable adverse effects on fruit quality. (C.H.)

15952 (CONF-641002(p.49-52)) DOSIMETRY, TOLERANCE, AND SHELF-LIFE EXTENSION RELATED TO DISINFESTATION OF FRUITS AND VEGETABLES BY GAMMA IRRADIATION. Edward Ross (Hawáii Univ., Honolulu. Coll. of Tropical Agriculture).

Practically all fruits and vegetables, and some flowers, are subject to rigid plant quarantine restrictions for outshipment to the Mainland U. S. from Hawaii. The present commercial variety of pineapple, which does not carry fruit fly infestation, is permitted for shipment without restrictions. Fumigation by ethylene dibromide is required prior to shipment for papaya fruits. Since 1954 the Hawaii Fruit Fly Investigations Laboratory, U. S. D. A. has been developing information on ionizing radiation dosage requirements to obtain disinfestation. A 416 curie cobalt-60 facility was installed at that time for this purpose. Experiments to date have indicated that low dosages of 20 to 25 krad can effectively disinfest papaya, cucumber, lychee, and tomato. Insect species were found to vary in susceptibility and fruit varieties to vary in tolerance. Mango fruits present a special problem by reason of seed weevil infestation. Although naked weevils can be sterilized or killed with 25 krad, those in the seeds inside the fruit resist external dosages up to 100 krad. Present evidence indicates that gamma irradiation dosages to prolong the shelf-life would be sufficiently high to insure disinfestation. (C.H.)

15953 (CONF-641002(p.53-5)) EXTRACTIVE STUDIES ON PACKAGING MATERIALS TO BE USED WITH IRRADIATED FOODS. (Hazleton Labs., Falls Church, Va.).

Samples of commercial food packaging materials were studied to determine what effect, if any, low dose radiation has on the nature or amount of extractives obtained using water, dilute acetic acid, and heptane as food-simulating solvents. The extraction cells containing the test films in contact with the solvents were exposed to 1.0 megarad of radiation from a cobalt-60 source. The irradiated cells were then placed in storage along with nonirradiated controls for one week at 70°F and 75% relative humidity. Total extractives from these films were determined gravimetrically at the end of this storage period. The water and acetic acid extractives were further extracted with chloroform and the chloroform soluble residues were determined gravimetrically. Infrared spectra were obtained on the chloroform soluble extractives from both the irradiated and nonirradiated samples. The data indicate there was no significant difference between the extractives obtained from the irradiated films as compared to the controls. (C.H.)

15954 (CONF-641002(p.57-9)) ECONOMIC FEASIBILITY OF RADIATION-PASTEURIZING FRESH STRAWBERRIES AND OTHER SELECTED PRODUCE ITEMS. SOME RESULTS OF A PRELIMINARY STUDY. John H. Droge (Economic Research Service, Washington, D. C.)

Preliminary estimates of spoilage loss reduction reveal that enough money can be saved to pay radiation-pasteurizing costs for strawberries. Additional savings may be realized because the cold storage life of the berries is increased, less in-store culling would be necessary, more units may be sold from a shipment before the price must be reduced due to product deterioration, and carbon dioxide gas is not then needed as a mold inhibitor, but it might be beneficial. Considerable potential exists for spoilage loss reduction of fresh peaches, tomatoes, oranges, and grapefruit, but more technical information is required from current research before estimates of economic feasibility of radiation-pasteurization can be made for them. Cost estimates of food irradiation facilities are included. (C.H.)

15955 (CONF-641002(p.60-2)) CURRENT STATUS AND PROSPECTS FOR THE COMMERCIALIZATION OF RADIATION PRESERVATION OF FOOD. Harry W. Ketchum and Jack W. Osburn, Jr. (Bureau of Business and Defense Services Administration, Washington, D. C.).

Results are summarized from a comprehensive analysis of the current status of food irradiation, by process and product, including judgments as to which foods and processes appear to have the best potentials for commercialization. Twenty-six products were considered in conjunction with six radiation processes: sterilization, pasteurization, disinfestation, disinfection, sprout inhibition, and product improvement. The commercial prospects for both domestic and international markets for 16 of these with good or excellent potentials were evaluated. It was concluded that food irradiation will not become a universal process, nor will it substantially replace alternative methods. It will, however, evolve as a major technique within the next decade, utilized by many types of processors with benefits to producers, distributors, and consumers. (C.H.)

15956 (CONF-641002(p.73-6)) RADIATION PASTEURIZATION OF FOODS—SUMMARY OF ACCOMPLISHMENT, (JULY 1–OCTOBER 15, 1964). (AME Associates, Princeton, N. J.).

Sweet cherries, apricots, prune-plums, and onions were irradiated and frozen for use in studies of their toxicological effects when included in the diet of rats and dogs. No results are included. (C.H.)

15957 (CONF-641002(p.77-81)) A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B AND E. J. T. Graikoski and L. L. Kempe (Michigan Univ., Ann Arbor).

Results are reported from studies on the effects of γ radiation on the germination and toxin synthesis of spores of Clostridium botulinum type E. Data are included from studies on the effects of radiation processing on the germination of C. botulinum spores in clams, haddock, and oysters. (C.H.)

15958 (CONF-641002(p.88-93)) THE SIGNIFICANCE OF CLOSTRIDIUM BOTULINUM TYPE E IN THE APPLICATION OF RADIATION-PASTEURIZATION PROCESS TO PACIFIC CRAB MEAT AND FLOUNDER. M. W. Eklund and F. T. Poysky (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

Results are reported from a study of the incidence of Clostridium botulinum in marine muds and crabs from the area of Ketchikan, Alaska, Bellington and Grays Harbor, Washington, and the mouth of the Columbia River. No loss of toxin titers occurred in crab stored for 30 days at 0°F. (C.H.)

15959 (CONF-641002(p.103-6)) BIOCHEMISTRY AND PHYSIOLOGY OF IRRADIATED FRUITS AND VEGETABLES. (New York State Agricultural Experiment Station, Geneva).

Results are reported from studies on the effects of γ radiation on the texture, taste, color, respiratory activity, and storage life of cherries, apples, and carrots. Data are included from tracer studies of glucose and pyruvate metabolism in irradiated carrot tissue. (C.H.)

15960 (CONF-641002(p.107-9)) RADIATION BIOCHEMISTRY OF FRUIT. Roger J. Romani (California Univ., Davis).

The effects of radiation on enzyme activity and the production of free radicals in fruits were studied. Emphasis was placed on the effects of radiation processing on the wholesomeness of fruits. (C.H.)

15961 (CONF-641002(p.110-13)) THE RADIATION PHYSIOLOGY AND MICROBIOLOGY OF FRUIT DETERIORATION. N. F. Sommer and E. C. Maxie (California Univ., Davis).

Results are reported from studies on the role of fungi in the deterioration of fruit. It is pointed out that the use of radiation as a fungicidal treatment is limited by host responses. Data on the fungicidal effects of radiation on strawberries infected by Botrytis cinerea (gray mold disease) are given. (C.H.)

15962 (CONF-641002(p.133-50)) THE USAEC PROGRAM ON FOOD IRRADIATION. Kevin G. Shea (Division of Isotopes Development (AEC), Washington, D. C.).

Recent developments in the radiation processing of foods are reviewed. Food irradiation facilities are discussed. Results are reviewed from pilot studies and regulations concerning the sale of irradiated foods are summarized. A list is included of research studies related to various aspects of the food irradiation program. (C.H.)

15963 (CONF-641002(p.159-78)) FACILITIES SUPPORTING AEC FOOD IRRADIATION RESEARCH. George R. Dietz (Division of Isotopes Development (AEC), Washington, D. C.).

Design features of food irradiation facilities are described. These include stationary, mobile, and on-board-ship irradiation facilities. (C.H.)

15964 EFFECTS OF SOAKING IN WATER, THERMAL ENZYME INACTIVATION, AND IRRADIATION ON THE TEXTURAL FACTORS OF BEEF. A. A. El-Badawi, A. F. Anglemier, and R. F. Cain (Oregon State Univ., Corvallis). Food Technol., 18: 149-52(Nov. 1964).

The influence of soaking meat in water, thermal enzyme inactivation, and irradiation on the textural characteristics of beef were studied in an attempt to clarify this over-tenderizing action of irradiation. Irradiation-sterilization of beef at 4.5 Mrad caused tenderization of the meat, and beef soaked in distilled water for 72 hr prior to heat inactivation of the enzymes and irradiation was much firmer. Beef heated to 160°F prior to irradiation also resulted in meat having a firm texture. Irradiation tended to reverse the effects of both soaking and heating and/or combination of these two treatments. Heating meat to an internal temperature of 160°F reduced the solubility of meat proteins apparently caused by heat denaturation and a salting-out effect. The fragmentary alterations of muscle proteins, followed by incorporation of water within the fragments and, possibly, a salting-in effect, appeared to be the main

factors responsible for the irradiation effects on beef muscle texture. Zinc cations complexed with proteins or enzymes will become insoluble when the zinc-containing proteins are subjected to heat at 160°F. The possibility of using the Zn content of the meat juice as a measure of the solubility of meat proteins is suggested. The correlation coefficient between the shear value and Zn of the separated juice was negative and significant, indicating that the higher the Zn content of the juice, the more tender the meat. Total Ca was not significantly changed by the various treatments. Free Ca was reduced by soaking, increased by cooking, and decreased by irradiation. Total Mg was decreased significantly only by soaking, while free Mg was also decreased by soaking, increased by cooking, and not affected by irradiation. Free K was reduced by soaking and increased slightly by cooking. Irradiation alone had no effect on the K of the separated juice. Conversely, irradiation after soaking and cooking caused a slight increase in free K. (BBB)

15965 EFFECT OF IRRADIATION AND PREIRRADIATION TREATMENTS ON BEEF MUSCLE PROTEINS. A. F. Anglemier, A. A. El-Badawi, and R. F. Cain (Oregon State Univ., Corvallis). J. Food Sci., 29: 837-42(Nov.-Dec. 1964).

Soaking beef in an equal weight of distilled water for 72 hr at 38°F and/or heating it to an internal temperature of 160°F increased meat firmness, whereas irradiation of beef steaks at the 4.5-MRad level caused considerable tenderization. Moreover, radiation nullified the effects of soaking and/or heating upon meat texture. It was found that the changes in texture resulting from soaking and heating beef steaks, and then irradiating to a level of 4.5 Mrad, are not due to the loss of the acidic and basic groups of the muscle proteins. A shift in the pH-hydration curve of the meat by soaking appeared to be caused by diminution of the muscle anions and/or partial denaturation of some of the muscle proteins. Thermal inactivation of the enzymes also tended to increase the firmness of meat, by causing a tightening of the meat structure, whereas radiosterilization may exert only a slight tightening of muscle structure, by increasing the number of the relatively weak hydrogen or electrostatic bonds. When meat was heated and then irradiated, however, the effect of cooking was dominant. Heating to 160°F resulted in the loss of 7 to 10 electrophoretic fractions from the proteins soluble in the glycine-NaOH buffer. Conversely, irradiation appeared to have very little effect on the electrophoretic pattern of the glycine-NaOH-soluble extract, with disappearance of only one band. Since radiosterilization caused a fragmentary action on the meat proteins, the number of the electrophoretic fractions was expected to increase rather than to decrease. This, however, can be explained by one of two possibilities: first, the protein fragments are held together by the hydrogen and/or the electrostatic bonds; second, the irradiation fragmentation effect is exerted mainly on the meat proteins not extracted by the glycine-NaOH buffer, such as the stroma proteins. (TCO)

15966 MEASUREMENT TECHNIQUES USED IN INDUSTRIAL RADIOISOTOPIC TRACER STUDIES. Ernoe Bujdoso (Research Inst. of Metals Industry, Budapest). Magy. Fiz. Folyoirat, 12: 491-8(1964). (In Hungarian)

The amount of isotopic tracers used in industrial measurements is limited by the activity permitted by the radiation safety regulations. Therefore, methods involving the use of very sensitive instruments were developed for measuring the activity of gamma-emitting isotopes used in industry. Good geometry was employed and the volume of the sample was increased to the maximum permissible level. In order to determine whether the instrument is stable and accurate, the background and the activity of a known reference standard were measured at regular intervals (after every fifth sample). The data allowed determination of whether the 95 or 99% reliability level has been reached; if not, corrections must be made. For processing requiring long time periods, recording rate meters or printing counters were used. As a practical example, the use of ^{59}Fe in tracer studies was reviewed. The MPC value of this isotope in the drinking water is 6×10^{-4} $\mu C/ml$. The calculations showed that under these conditions and assuming a 10-minute long recording time and a background of 25 cpm, the accuracy of the measurement is 1.5%; in the case of ^{65}Zn, the accuracy was 2%. The sensitivity may be increased by the use of a NaI(Tl) scintillation detector. The standard deviation calculated referred to statistical errors involving a simple scaler; this may be further reduced by using an instrument with suitable energy discrimination. (TTT)

15967 TRITIUM IN BIOLOGY AND MEDICINE. V. F. Zhuravlev. Med. Radiol., 9: No. 12, 63-70(Dec. 1964). (In Russian)

Sixty articles on the use of tritium in biological and medical research are reviewed. (IIC-MG)

15968 IRRADIATION OF FOODS AS A PRESERVING METHOD, ITS SOURCES AND PRINCIPLES OF DOSIMETRY. Teodor Gruenewald. Prumysl Potravin, 15: 71-5(1964). (In Czech)

Basic principles concerning the irradiation of foods, especially the sources of radiation and radiation dosimetry, which have considerable significance in this field of study, are discussed. Following a brief introduction to the physics of ionizing radiation, different possible sources for food irradiation are discussed, emphasizing methods for surface irradiation. It is concluded with a discussion of dosimetry with emphasis on chemical dosimeters for surface irradiations. (TTT)

15969 APPLICATION OF IONISATION RADIATION IN FOOD INDUSTRY FOR COLD STERILIZATION. Augustin Wolf. Prumysl Potravin, 15: 76-9(1964). (In Czech)

The application of radiation for sterilization in various countries is reviewed. Complete sterilization with doses of 2 to 5 MR has been used with meat, fish, poultry, cheese, meat products, prepared foods, relishes, and packaging materials. With most of these materials, radiation cannot replace classical sterilization methods. Radiopasteurization, i.e., with doses of 100 to 300 kRads, has been used to increase the storage life of meat, fish, etc., and has prospects for practical application. The third category of small doses of 10 to 30 kRads has the greatest hope for practical application in the near future. A dose of 25 kRads is used for safeguarding grain against weavils, etc., 12 kRads against trichinae in meat, and 5 to 10 kRads to hinder sprouting of potatoes, for stabilizing cider, and for slowing down ripening. Several references are cited concerning studies of the effects of radiation on the quality of foods and on the effect of irradiated food on animals. (TTT)

15970 APPLICATION OF RADIOISOTOPES IN MEASURING AND CONTROL DEVICES. Zdenek Hyrs. Prumysl Potravin, 15: 80-2(1964). (In Czech)

Radioisotope methods, which are bringing great savings into many fields, will be introduced also into the food industry for their specific advantages, chiefly as measuring sensors for the automatization of operations. In other countries they are assembled in arrangements for different measurements; for measuring water levels, for measuring density, for counting objects on belts, and for control in package fillings. The problem of the safety of the work has been solved in this country by regulations, e.g., ČSN341730Sb. part 19, April 25, 1963, without which it would be impossible to manage such operations. The conditions for the safe use of radiation are assured or at least provided for directly by the manufacturer of the various types of apparatus. Brief descriptions are given of the principles involved in the use of radioisotopes for the measurement of liquid level, density, thickness, and for the measurement of the thickness of a coating layer by means of back-scattered radiation. (TTT)

15971 BIBLIOGRAPHY ON INDUSTRIAL RADIOLOGY, 1962-1964. Herbert R. Isenburger. 10th Supplement to "Industrial Radiology." Califon, N. J., St. John X-Ray Laboratory, 1965. 20p. $3.00.

References (669) are given to U. S. and foreign journals and reports published from 1962 through 1964. (P.C.H.)

Power Application

Refer also to abstract 17350.

15972 (BMI-1709) FABRICATION STUDIES ON Pm^{147} BETAVOLTAIC BATTERIES. Russell H. Barnes, Robert L. Ritzman, John F. Kircher, and Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Jan. 25, 1965. Contract W-7405-eng-92. 43p. Dep.; $1.00(cy), 2(mn) CFSTI.

Techniques for preparing betavoltaic batteries consisting of a thin layer of ^{147}Pm in the form of hydrated Pm_2O_3 sandwiched between two standard n-on-p silicon solar cells and encapsulated in a $^{13}/_{16}$-in.-diameter by $^{7}/_{8}$-in.-long Type 304 stainless steel case were studied. The ^{147}Pm was purified by ion exchange, using alpha-hydroxy isobutyric acid as the elution agent. Low-intensity light sources were used to select the solar cells. Batteries containing 2, 4, and 8 curies of ^{147}Pm were prepared. Power outputs from the 2-curie units averaged about 3 μw, with the maximum output for any one battery being 5.7 μw. The 4-curie units averaged 8 μw, with a maximum of 9.3 μw for one battery. The single 8-curie battery prepared produced 10.7 μw. It was concluded from the study that major increases in battery performance should come from use of solar cells designed for low-power operation with a ^{147}Pm beta source. (auth)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures.

Refer also to abstract 16852.

15973 (MLM-1163(p.D-1-9)) OTHER ISOTOPE SEPARATION METHODS UNDER INVESTIGATION AT MOUND LABORATORY. K. W. Foster (Mound Lab., Miamisburg, Ohio).

Photochemical methods are inexpensive, relatively simple, and have moderately good enrichment. However, the total throughput capacity per unit is very low, being of the order of a few milligrams per day. As yet the method has been used successfully only on mercury, and extension to other elements is a formidable problem with no guarantee of solution. The mass filter is more expensive but has, in theory, excellent resolution and can be adapted to any light or medium weight element which can be ionized at reasonable potentials. The total throughput per unit can apparently be increased to the order of grams per week. Generally, there is an appreciable loss of source materials during the process so that recovery of a scarce source material would be a problem. Extension of the method to very heavy elements is not encouraging at present. Centrifuges have an inherently high capacity and possess definite advantages over other methods for the high mass elements. However, the separation per unit is quite low and a cascade system is required for significant isotope enrichments. (auth)

15974 (MLM-1163(p.E-1-6)) HELIUM RESEARCH: SUPERFLUIDITY AND THERMOMETRY. E. W. Wiederhold and J. W. Snider (Mound Lab., Miamisburg, Ohio).

The separation of ^3He and ^4He by means of the superfluid effect was studied. The effects of ^3He concentration on the lambda temperature of ^4He are described. Results are given of preliminary helium separations with Pt-pyrex superleaks; the enrichment factors are well below the limit suggested for an ideal superleak. The use of ^3He in thermometry at low temperatures is discussed. The disadvantages of ^4He and the advantages of ^3He for thermometry are pointed out. Thermomolecular pressure corrections are considered briefly. (D.L.C.)

15975 (ORNL-3770) ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF OSMIUM ISOTOPES. R. L. Johnson, C. W. Sheridan, W. A. Bell, Jr., C. V. Ketron, L. O. Love, W. C. Davis, F. B. Thomas, and W. K. Prater (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 28p. Dep.; $2.00(cy), 1(mn) CFSTI.

Laboratory experiments verified that OsO_4 was sufficiently stable for use as feed material in an electromagnetic isotope separation and that the reactivity of osmium metal with air was slow enough to permit recovery of enriched isotopic material. Equipment modifications partially offset the low rate of separation which was imposed by restrictions and controls adopted to assure the personal safety of those working with volatile and toxic OsO_4. Chemical recovery and refinement were achieved by trapping OsO_4 in hydrobromic acid, precipitating hydrated OsO_2, and reducing to the metal with hydrogen. More than 39 g of enriched osmium isotopes were made available for research programs. (auth)

15976 SEPARATION OF POTASSIUM ISOTOPES BY ZIRCONYL PHOSPHATE IN FUSED POTASSIUM NITRATE. Mutsuaki Shinagawa, Emiko Oyoshi, and Akira Oyoshi (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 1: 362-3 (Dec. 1964).

The isotope separation of potassium was studied using zirconyl phosphate as an ion exchanger in fused potassium nitrate. The experiments were performed with thoroughly dehydrated media, which appeared to be more effective for the ion exchange reaction of isotopes. (C.E.S.)

15977 NEON ISOTOPE FRACTIONATION DURING TRANSIENT PERMEATION. S. N. I. Rama and S. R. Hart (Carnegie Institution of Washington, D. C.). Science, 147: 737-8(Feb. 12, 1965).

Fractionation of ^{20}Ne with respect to ^{22}Ne during a single-stage transient permeation process resulted in as much as 45% enrichment of ^{20}Ne. The observed fractionations agreed with calculations from simple diffusion theory. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 16274 and 16722.

15978 (ANL-6952) APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1963–JUNE 30, 1964. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 101p. Dep.; $4.00(cy), 2(mn) CFSTI.

A summary is presented concerning each program initiated or changed during the period. In other sections, research on programming is described along with computer engineering and computer systems development. A list of publications and papers associated with the division is included, and seminars, symposia, and lectures of interest in mathematics are noted. (J.R.D.)

15979 (COO-427-44) THE REPRESENTATION THEORY OF LIE GROUPS. Joseph Kahane (Notre Dame Univ., Ind.). [1963]. Contract AT(11-1)-427. 65p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

Notes are presented from a series of lectures on the mathematical bases of physical symmetry-group studies. (T.F.H.)

15980 (EUR-2186.e) ON VARIETY SEPARABILITY OF SUBSETS OF A MONOID, WITH APPLICATIONS TO FINITE AUTOMATA. L. A. M. Verbeek (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and European Atomic Energy Community Ispra (Italy). European Scientific Data Processing Center). 1964. 16p. (CONF-641209-1). Dep.(mn).

From International Summer School of Physics Course on Automata Theory, Ravello, Italy.

Let $\underline{R} = [R_i : i \in I]$, where I is an index set, be a collection of disjoint subsets of a monoid F, and let $\underline{V}$ be a variety of monoids. $\underline{R}$ is said to be $\underline{V}$-separable if there exists a homomorphism γ of F on a monoid $M \in \underline{V}$ such that M contains a collection of disjoint subsets $\underline{P} = [P_i : i \in I]$ for which $\gamma^{-1}P_i \supseteq R_i$ for each $i \in I$. Necessary and sufficient conditions are derived for variety separability. In case $\underline{R}$ is a collection of regular events, these conditions yield an effective procedure for deciding whether $\underline{R}$ is separable by a given variety of monoids. (auth)

15981 (ORNL-3714(Vol.I)(p.70-7)) MATHEMATICS AND COMPUTER PROGRAMS. (Oak Ridge National Lab., Tenn.).

Research is summarized on Hauser-Feshback computer programs, programs for use in estimation of neutron fluxes in anisotropic scattering media, and programs for neutron scattering. A processing code for O5R collision tapes is included, and derivation of estimators for scattered particle fluxes is described along with a code for gamma transmission. An algorithm for inverse matrix working is included, and development of a statistical approach for instrument measurements related to unknown functions is reported. Development of a one-constraint LaGrange multiplier formulation is reported. References to publications in which the research is described are included. (J.R.D.)

15982 (SC-DC-65-1132) A PRECISION ANALOG MEMORY WITH NON-DESTRUCTIVE READOUT USING MULTIAPERTURE FERRITE CORES. Andrew C. Wilken (Sandia Corp., Albuquerque, N. Mex.). [Jan. 1965]. Contract [AT(29-1)-789]. 36p. (CONF-650403-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From International Conference on Non-Linear Magnetics, Washington, D. C.

The utilization of a square loop multiaperture ferrite core in conjunction with solid state switches results in a device that is capable of non-destructively interrogating the flux content about the core's minor aperture. The minor aperture flux can be controlled by a signal applied to the major aperture. The minor aperture flux quantity is the frequency controlling element of a readout oscillator which is the interrogator. There is, therefore, an analog input to frequency output which can be easily calibrated. The circuit can be operated in a completely passive mode at all times except during the interrogation cycle. The information, once stored as a flux reversal in the multiaperture core, can be maintained for an infinite time interval or until reset. (auth)

15983 (TID-21304) A TABULATION OF THE DOPPLER INTEGRALS $\Psi(x,t)$ AND $\phi(x,t)$. Kamal K. Seth (Duke Univ., Durham, N. C.; Northwestern Univ., Evanston, Ill); and R. H. Tabony (Duke Univ., Durham, N. C.). [196?]. Contract AT(40-1)-3065. 32p. Dep.; $2.00(cy) 1(mn) CFSTI.

The Doppler integrals have been calculated over a wide range of arguments, $t = 0$ to 10,000 and $x = 0$ to $20\sqrt{t}$, with an accuracy better than 0.2 per cent. The results for $\Psi(x,t)$ are compared with other published and unpublished calculations and errors in calculations are brought to notice. (auth)

15984 STATISTICAL ENSEMBLES OF COMPLEX: QUATERNION, AND REAL MATRICES. Jean Ginibre (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 6: 440-9 (Mar. 1965).

Statistical ensembles of complex, quaternion, and real matrices with Gaussian probability distribution, are studied. The overall eigenvalue distribution is determined in these three cases (in the real case, under the restriction that all eigenvalues are real). In the complex case, all the correlation functions of the eigenvalues are also determined, as well as their limits when the order N of the matrices becomes infinite. In particular, the limit of the eigenvalue density as $N \to \infty$ is constant over the whole complex plane. (auth)

15985 SOME RECENT DEVELOPMENTS IN INVARIANT IMBEDDING WITH APPLICATIONS. Paul B. Bailey and G. Milton Wing (Sandia Lab., Albuquerque, N. Mex.). J. Math. Phys. (N. Y.), 6: 453-62(Mar. 1965). (SC-DC-64-1439)

A summary of some recent developments in the theory of invariant imbedding is presented. Applications to some simple problems in wave propagation, diffusion theory, and transport theory demonstrate some of the advantages of the new and almost mechanistic approach. In addition, a slightly different attack is applied to nonlinear difference equations and to the classical phase-shift problem. (auth)

15986 ON THE RACAH ALGEBRA FOR THE GROUP R_4. G. Ponzano (Universita, Turin). Nuovo Cimento (10), 35: 1231-3(Feb. 16, 1965).

The 6j symbol for the simply reducible rotation group R_4 is calculated, and the properties of the Racah algebra of compact simply reducible groups is verified directly in this case. (D.C.W.)

15987 COMPUTERS FOR DOSE PLANNING. R. E. Bentley (Royal Cancer Hospital, Belmont, Eng.). Proc. Roy. Soc. Med., 57: 352(May 1964).

A digital computer may be used as an aid in the calculation of dose distributions for multiple field therapy. It may be used to add together the doses due to several fields and produce, automatically, a printed isodose distribution. This results in a considerable saving of labor compared with conventional methods, particularly for plans for treatment by rotation. (BBB)

15988 NON-SEPARABLE SOLUTIONS OF THE HELMHOLTZ WAVE EQUATION. Donald S. Moseley (Vitro Labs., Silver Spring, Md.). Quart. Appl. Math., 22: 354-7(Jan. 1965).

A set of solutions not obtainable by the method of separation of variables is presented for the vector Helmholtz wave equation in circular cylindrical coordinates limited to non-angular dependence. These are constructed of Bessel and trigonometric functions. Brief reference is made to three-dimensional solutions in rectangular coordinates. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstract 17183.

15989 (AFML-TR-64-362) THE PREPARATION OF ORIENTED SINGLE CRYSTAL SPHERES OF INTERMETALLIC COMPOUNDS BETWEEN THE RARE EARTH AND IRON GROUP METALS. James F. Nester (Perkin-Elmer Corp., Norwalk, Conn.). Nov. 1964. 28p.

A process was developed whereby single crystals of incongruently melting intermetallic compounds between rare earth and iron group transition elements can be grown and fabricated into small spheres. Single crystals of YCo_3, $NdCo_3$, $DyCo_3$, and "YFe_3" were grown, and spheres up to 2.67 millimeters in diameter were fabricated from these materials (with the exception of $DyCo_3$). Metallographic techniques were developed for these materials, and in many cases the results differed substantially from published data. Metallographic and x-ray techniques were used to establish the single crystal character of the materials. The process is discussed in sufficient detail to permit its duplication in other laboratories, and recommendations are made for improving the process in subsequent applications. (auth)

15990 (BMI-1708) PREPARATION AND EVALUATION OF ALUMINA-COATED FUEL PARTICLES. Melvin F. Browning, Virginia M. Secrest, and John M. Blocher, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 20, 1965. Contract W-7405-eng-92. 74p. Dep.; $1.75(cy), 2(mn) CFSTI.

Dense high-purity alumina coatings were applied to UO_2 particles in a fluidized bed by the hydrolysis of $AlCl_3$ vapor. These coatings were sufficiently impervious to show excellent fission-gas retention upon heating to 1300°C after a low neutron exposure. Alumina-coated UO_2 fuel particles withstood 10 at.% burnup at 900°C with essentially no release of ^{133}Xe. The most satisfactory coatings were deposited at about 1000°C and appeared to have a structure consisting of submicron grains of alpha-alumina in an amorphous matrix. Alumina deposited at 1300°C was less desirable because of its large-grained anisotropic structure, which was inherently weaker and more susceptible to thermal stress. Porous coatings were obtained at deposition temperatures of 500 to 900°C. At deposition temperatures of 1000 to 1400°C, the alumina was equivalent to synthetic sapphire in hardness and density. The properties of dense alumina coatings were not grossly affected by varying the deposition rate between 1.5 and 10 μ per hr or the stoichiometric excess of oxidizing agent between 20 and 70 per cent. The addition of MgO to the alumina during deposition inhibited grain growth on subsequent heat treatment. (auth)

15991 (BNL-841(p.63-101)) METALLURGY DIVISION. D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.).

A pure Ta boiling Hg thermal convection loop is still in operation after 9682 hr with no sign of corrosion. Nb–1 Zr bent specimens in reflux capsules cracked in Hg at 760°C on the inside of the bends; unalloyed Nb does not crack under the same conditions. The second Nb–1 Zr boiling Na thermal convection loop was shut down after 5000 hr of successful operation. Hot cell examination of the MTR Dy_2O_3 specimen showed swelling; the clad and meat separated when the samples were cut. A calculation of the ordering energy of β-CuZn yielded results in good agreement with specific heat measurements. Electromigration studies of Ag-Bi alloys are complete; effects of time, temperature, concentration, and current density are given. Hg solubility studies were completed. Both lattice parameters and thermodynamics (by an emf method) of substoichiometric ThC were studied. The release of Xe from $(Zr_{0.995}\ U_{0.005})C_{0.99}$ is in agreement with a diffusion model over the range 1500 to 1900°C. Nb does not develop a sharp ductile-to-brittle transition after 2×10^{19} nvt. Twinning in irradiated Fe does not affect the dependence of the yield stress on temperature, but may play some role in the ductile-to-brittle transition. Irradiation-produced defects in pure Fe are only visible by transmission microscopy after the specimens are heat-treated. After 2 hr at 350°C, dark spots appear; after 2 hr at 400°C and above, these spots resolve into small circular dislocation loops probably lying parallel to the {110} planes of the Fe lattice. Dimensional recoveries of BGRR graphite samples are given and compared with total growth that would have occurred over the same period without periodic annealing. The defects responsible for the radiation-enhancement of graphite oxidation appear to be removed when the graphite is alternately irradiated and annealed. A continuous irradiation of 110 days leads to a greater enhancement of oxidation rate and a lower activation energy than irradiations ten times greater. Decomposition of Cs-graphite lamellar compounds in pyrolytic graphite occurs in 3 stages, two of which are controlled by removal of Cs from the solid surface, whereas the third is controlled by diffusion of Cs through the solid. (auth)

15992 (CEA-R-2577) CONTROLE PAR ULTRA-SONS DES TUBES DE GAINE EN ACIER INOXYDABLE DU REACTEUR EL 4. (Ultrasonic Control of Stainless Steel Clad Tubes of the EL4 Reactor). A. C. Prot and P. R. Monnier (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Aug. 1964. 28p. Dep.(mn).

From all the methods possible for controlling thin cans, the one chosen, for numerous reasons, was that making use of ultrasonic techniques. A method has been developed which should make it possible to carry out a rapid and efficient industrial control of canning tubes. The reasons for the choice of the ultrasonic method are given in detail, together with the principles of the method and the actual control parameters. In the present state of research, it should be possible to control at least 50,000 tubes a year. Improvements brought about in the details of the control technique itself should make it possible to increase this rate considerably. (auth)

15993 (GA-5640) VAPOR-DEPOSITED TUNGSTEN. (General Atomic, San Diego, Calif.). Oct. 6, 1964. Contract NAS3-4165. 27p. (NASA-CR-54266; N65-15591). $2.00(CFSTI).

Compatibility data for candidate fuel-cladding combinations for nuclear-heated thermionic diodes are given which show that the only compatible cladding material is tungsten. Because of the difficulties of working of conventional tungsten stock, chemical vapor deposition was investigated and found to satisfy thermionic requirements. The following properties of vapor-deposited tungsten are described: purity, mechanical properties, resistance to grain growth, preferred orientation, machining, joining, and fabrication into complex shapes. (D.L.C.)

15994 (HW-84281) METALLURGY RESEARCH OPERATION. Quarterly Progress Report, July–September 1964. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation. Sept. 15, 1964. Contract AT(45-1)-1350. 148p. Dep.; $4.00(cy), 3(mn) CFSTI.

Separate abstracts were prepared for the fifteen sections of the report. (J.R.D.)

For abstracts of individual sections see: 16016, 16017, 16018, 16072, 16209, 16210, 16211, 16212, 16213, 16214, 16215, 16216, 16217, 17337, and 17361.

15995 (IITRI-B231-11) PILOT EVALUATION OF VANADIUM ALLOYS. Appendix to Final Report. F. C. Holtz (IIT Research Inst., Chicago, Ill.). Jan. 25, 1965. Contract NOw-62-0101-c. 34p.

Results are presented of additional evaluations of vanadium alloys by organizations participating under the data exchange portion of this program. Sheet specimens from

100-lb ingots of V–20Nb–4Ti–1Zr–0.075C and V–60Nb–1Ti were evaluated for tensile, recrystallization, corrosion, oxidation, and other properties. High ductility was found at –452°F; elevated-temperature data for V–60Nb–1Ti confirmed the high density-corrected strength values previously reported. Silicide-coated specimens of this alloy withstood 206-min cycles at temperatures up to 2900°F in low-pressure Mach 1 air stream reentry simulation tests. (auth)

15996 (IITRI-B6019-4) HIGH-TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report, April 1–May 31, 1964. Larry I. Kane and John J. Rausch (IIT Research Inst., Chicago, Ill.). July 1, 1964. Contract NOw-64-0140-c. 21p. $1.00(CFSTI).

Oxidation-protective coatings for vanadium-base alloys are being developed for use at 1800 to 2500°F. The effect of pack-siliconizing on the mechanical properties of 0.020 in. thick sheet of V–60 wt % Nb–1 wt % Ti is being studied. Preliminary results indicate that the siliconizing process has no effect on strength, but causes some reduction in tensile ductility. The transition temperature of the coated alloy is below +32°F; its lower limit is currently being determined. The development of an oxidation-resistant slurry or liquid cementation type of coating for V–60 wt % Nb–1 wt % Ti is progressing. Slurry compositions containing tin, silicon, silver, copper, aluminum, and niobium have been investigated; several of these show good coverage, even at corners and edges. The static oxidation life of other promising vanadium-base alloys, coated by the pack-siliconizing process is also being investigated. (auth)

15997 (K-L-6020) PREPARATION OF REFRACTORY METAL POWDERS WITH UNUSUAL PROPERTIES. S. H. Smiley, D. C. Brater, and H. L. Kaufman (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 26, 1965. Contract W-7405-eng-26. 25p. (CONF-650203-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The reduction of WF_6 and MoF_6 to fine metal powders with high purity and surface area was carried out using a H_2–F_2 flame. The "cold wall" reactor process used to reduce UF_6 to UF_4 and subsequently adapted for reduction of WF_6 and MoF_6, is described. The effects of the variables on the properties of the powders were studied. The preparation of Mo–W and Re–W alloy powders by coreduction of their fluorides was also investigated. (D.L.C.)

15998 (LA-3118) FUSED SALT ELECTROREFINING OF MOLTEN PLUTONIUM AND ITS ALLOYS. L. J. Mullins and J. A. Leary (Los Alamos Scientific Lab., Univ. of California, N. Mex.). July 20, 1964. Contract W-7405-eng-36. 31p. (CONF-571-33). Dep.; $2.00(cy), 1(mn) CFSTI.

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Results of an extensive development program that culminated in construction of a 40 kg per month capacity electrorefining plant are reviewed. High purity plutonium is produced in good yield on the 0.2 to 3.5 kg scale. Impure plutonium metal, Pu-10 at. % Fe alloy, and Pu-3 at. % Ga alloy have been refined routinely to plutonium that contained less than 100 ppm by wt of metallic impurities. In addition to serving as a means of preparing high purity plutonium metal, the large scale process is used to recycle plutonium metal scrap economically. The theory of plutonium alloy electrorefining is developed. In particular the behavior of elements that are commonly present in impure plutonium metal, such as uranium, thorium, iron, and gallium, is reviewed. The special case of americium-241, which results from the decay of plutonium-241, is considered in detail. The distribution coefficients for americium between the molten salt electrolyte and the refined plutonium are reported. Results are correlated with thermodynamic properties and phase diagrams of plutonium alloy systems. The effects of process variables such as refining temperature, current density, molten salt electrolyte composition, and stirring on the process are discussed. In addition, various ceramics and refractory metals have been evaluated as container materials for molten salts and molten plutonium. (auth)

15999 (ML-TDR-64-277) RESEARCH ON RADIOGRAPHIC TECHNIQUES OF GRAPHITE EVALUATION. Merle L. Rhoten (Ohio State Univ. Research Foundation, Columbus). May 1964. Contract AF33(657)-11245. 99p.

Technique charts are presented for the radiography of graphite in the medium thickness range 2 to 14 inches using typical industrial x-ray equipment. Results of experimental data presented demonstrate that the problems in the radiography of graphite are due to scatter radiations and economics of inspection. The thicknesses of graphite billets (now ranging up to 103 inches) present geometrical unsharpness problems as related to economy of inspection. When the x-ray source is removed from the film sufficient distances to obtain a reasonable D/T ratio, exposure times become uneconomical. Techniques reported also demonstrate that better than 1 per cent radiography can readily be obtained using typical industrial techniques and lead filtering, for the ranges of thicknesses from ½ to 40 inches. (auth)

16000 (MLM-1163(p,N-1-10)) PREPARATION AND EVALUATION OF CERAMIC MATERIALS CONTAINING PLUTONIUM. P. A. Tucker (Mound Lab., Miamisburg, Ohio).

Two unique types of plutonium-bearing ceramic materials have been developed: glass and dense, crystalline microspheres. The most surprising characteristic of both is the contamination-free nature. The usefulness of the materials for alpha and neutron source applications has been shown. Both materials appear particularly attractive as potential reactor fuel materials. (D.L.C.)

16001 (ORNL-3514) MECHANICAL CLADDING-FUEL INTERACTIONS DURING THERMAL CYCLING OF METAL-CLAD FUEL ELEMENTS. W. R. Martin (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 31p. Dep.; $2.00(cy), 1(mn) CFSTI.

The effect of pressure and cladding thickness on the progressive extension of metal-clad UO_2 fuel elements during thermal cycling has been investigated. As a result of the data analysis, a model describing the progressive extension of the fuel elements during cycling is presented. The model describes the importance of contact pressure, coefficient of friction, and material properties as well as number and magnitude of the thermal cycles. The model indicates the ratchetting to be a special case of a low-cycle strain-fatigue problem. Hence, in the absence of ratchetting, cladding failures due to strain fatigue of cladding are also predicted by the model. (auth)

16002 (ORNL-P-358) IMPACT RESISTANCE OF FUELED GRAPHITE SPHERES FOR PEBBLE-BED REACTOR APPLICATIONS. C. O. Smith and J. M. Robbins (Oak Ridge National Lab., Tenn.). [Aug. 21, 1964]. Contract W-7405-eng-26. 41p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Graphite fuel spheres for on-stream fueling of gas-cooled reactors of the pebble bed-type must withstand repeated drops. A program to develop a fuel sphere to meet the requirements for the German Pebble Bed Reactor (AVR) focused attention on the machined-shell concept in which a premolded spherical fuel insert [containing pyrolytic-carbon coated $(Th,U)C_2$ particles in a graphite matrix] is cemented in a premachined, fully graphitized, unfueled shell. Two studies were undertaken: (1) evaluation of impact resistance of commercially available graphite for the shell and (2) determination of the minimum shell thickness required and the effect of insert-shell gaps, which could be present initially or develop during reactor operation. In the initial study, 1.5-in.-dia. spheres, machined from four grades of extruded graphite and four grades of molded graphite, were dropped from 13 m onto a steel plate until failure. Grade ATJ graphite was clearly the best and was used almost exclusively in further tests. The results of free-drop tests on ATJ show: (1) Impact resistance decreases as drop height increases. (2) Impact resistance depends on specimen size with best resistance in the smallest specimens. (3) Impact resistance varies from one block to another with no correlation between impact resistance of a given sphere and its original position in the block. (4) Bulk-density variations between 1.65 and 1.80 g/cm^3 have no effect on impact resistance. (5) All damage

occurs within the outer 7/16 in. of 6-cm-dia spheres. (6) Thermal cycling in vacuum can have an adverse effect while similar cycling in helium or hydrogen has none. Results of drop-weight tests substantiate the conclusions derived from free-drop tests. In the fueled-sphere tests, simulated elements (the fueled portion simulated by a sphere of solid CS-312 graphite) were dropped from 4 m onto a bed of graphite spheres until failure or 75 drops, whichever was less, followed by dropping of surviving elements from 4 m onto a steel plate to failure. The results are: (1) The effects of preassembly cleaning and variations in plug-closure torques between 15 and 50 in.-lb and in types of cements (P-514, C-10, and Hexalon) are negligible. (2) Elements with uncemented inserts are clearly inferior to elements with completely cemented inserts. (3) Shells with 0.8-cm-thick walls are satisfactory for nominal radial clearances between insert and shell of 0.005 to 0.010 in., but 1.0- to 1.2-cm-thick shells would be required for clearances of 0.020 to 0.025 in. (auth)

16003 (UCRL-7562) RECENT ADVANCES IN VACUUM METALLURGY IN THE UNITED STATES. R. F. Bunshah (Lawrence Radiation Lab., Univ. of California, Livermore). Nov. 11, 1963. Contract W-7405-eng-48. 44p. (CONF-631107-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 4th National Vacuum Symposium, Kyoto.

A review is presented of four recent advantages in vacuum metallurgy: (1) a vacuum mold degassing process, (2) two new high-power electron beam heating sources (hot hollow cathode plasma and cold grid-controlled plasma), and (3) a crucibleless vacuum induction melting and casting process. (D.L.C.)

16004 (UCRL-12223) MARAGING STEEL, A BIBLIOGRAPHY. Penelope Bloom (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 1964. Contract W-7405-eng-48. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

Approximately 300 references are presented which cover the time period 1962 to Oct. 1964. (D.L.C.)

16005 (AEC-tr-6537) THE SINTERING OF HIGH-PURITY MgO. P. P. Budnikov, M. A. Matveev, and V. K. Yanovskii. Translated by J. F. White from Dokl. Akad. Nauk SSSR, 159: 872-5(1964). 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL.

A study was made of the activation of high-purity MgO obtained from the hydroxide and carbonate, the effects of calcination and sintering temperatures, and the sintering mechanism. The optimum conditions for obtaining high-density MgO were found to be calcination of $Mg(OH)_2$ at 600°C and sintering at 1600°C. The sintering mechanism in the intermediate stage is volume diffusion with an activation energy of 3.7 ev, while another mechanism is operative in the initial stage. (D.L.C.)

16006 PYROCHLORE MINERALS AS A POTENTIAL SOURCE OF REACTOR-GRADE NIOBIUM. J. M. Bakes, P. G. Jeffery, and J. Sandor (Warren Spring Lab., Stevenage, Herts, Eng.). Nature, 204: 867-8(Nov. 28, 1964).

The prospect that high-purity niobium might be produced in the future from a suitable pyrochlore source without the expensive niobium–tantalum liquid-liquid separation step is discussed. Samples of pyrochlore were analyzed and Nb/Ta ratios as high as 5,808:1 were found. (C.E.S.)

16007 VACUUM EVAPORATION OF METALS BY HIGH FREQUENCY LEVITATION HEATING. J. Van Audenhove (EURATOM, Geel, Belg.). Rev. Sci. Instr., 36: 383-5(Mar. 1965).

The equipment for high-frequency levitation evaporation is described. This technique is successfully applied to evaporation of small quantities of Al, Ag, Ti, Co, Fe, Cu, and U. A small amount of starting material is needed, and at least 50% of the evaporated metal may be recovered easily. (auth)

16008 IMPROVEMENTS IN OR RELATING TO URANIUM ALLOYS. Malcolm Stevens and Wallace Albert Charles Pollock (to United Kingdom Atomic Energy Authority). British Patent 976,305. Nov. 25, 1964. Filed Apr. 19, 1962.

An alloy of U, Mo, Al, and Fe containing Mo in the range 0.25–0.6 wt %, Al in the range 0.04–0.15 wt %, and Fe in the range 0.0325–0.05 wt %, the balance being U and incidental impurities is described. The alloy was prepared by placing a Mg-reduced billet in a graphite crucible, adding Mo and Al in the form of a 3% or 6% master alloy with the U, adding the Fe in the form of strip, and melting the whole by high-frequency induction heating under vacuum. The melt was held at 1500–1550°C for 5 min and poured into a mold while still under vacuum. Bars of the alloy containing slightly varying amounts of the alloying metals were subjected to an isothermal heat treatment to allow isothermal transformation from the β to the α phase, and an irregular grain structure of grain size 0.2–0.3 mm maximum and 0.1 mm average was produced. This alloy is particularly suitable for use in reactor fuel elements because of the low Mo content and the irregular fine grain structure. (A.G.W.)

16009 NUCLEAR REACTOR FUEL ELEMENTS. Douglas White (to United Kingdom Atomic Energy Authority). British Patent 976,366. Nov. 25, 1964. Filed June 13, 1962.

A nuclear reactor fuel element composed of a plurality of UO_2 ceramic-type fuel members arranged end to end and enclosed in a protective sheath is described. Each fuel member is of generally truncated conical form, and the protective sheath of stainless steel is deformed into intimate contact with the fuel members by external pressure. The external contours of the sheath after pressing onto the pellets comprise a series of annular corrugations whose exact shape depends on the shape of the pellets employed. The ceramic pellets are formed by compacting UO_2 powder with a fugitive binder between dies followed by sintering at ~1650°C. The thickness to major diameter ratio of the fuel members is in the range 1:4 to 1:2, and the difference between the major and minor diameters is in the range of 0.010 to 0.040 in. (A.G.W.)

Corrosion

Refer also to abstracts 15712, 16059, 16186, 16217, and 17278.

16010 (ACNP-62024) CORROSION TESTING OF PATHFINDER SUPERHEATER FUEL ELEMENT MOCK-UP. C. R. Bergen (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.). Feb. 28, 1963. For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates. 47p.

A test using an electrically heated superheater element mock-up, was conducted to assure the integrity of Type 316L stainless steel as superheater fuel cladding in Pathfinder. The results indicate that stress corrosion will probably not be a problem. No evidence of significant chloride stress corrosion or intergranular attack was observed. Limited cracking was observed in a stagnant steam area not representative of Pathfinder superheater conditions. The corrosion of "A" nickel components by superheated steam is discussed. (D.L.C.)

16011 (AERE-R-4820) A REVIEW OF THE KINETICS AND MECHANISMS OF OXIDATION AND HYDRIDING OF ZIRCONIUM, ZIRCALOY-2 AND Zr–2½% Nb ALLOY. J. K. Dawson (Atomic Energy Research Establishment, Harwell (England)). Dec. 1964. 50p. Dep.; $1.40 (BIS), 7s.(HMSO).

The widely scattered and often contradictory evidence on kinetics and mechanisms of the oxidation and hydriding of zirconium and two of its technologically important alloys at temperatures below 400°C is reviewed. For reaction with oxygen, four distinct regions of the oxidation curves are defined. The control of the oxidation may differ in each of these regions, proceeding from an initial interface reaction through two stages of control by lattice diffusion of anions in the growing oxide film, to leakage path diffusion and finally to a complex equilibrium situation in the "post-transition" region. Some of the evidence indicates that the nature of the oxidation may not be the same in steam or

water as in oxygen, and that wide generalizations may not be possible. The effects of reactor radiations on the corrosion processes are described and their causes are discussed. Finally suggestions are made for further investigations which would clarify the many important controversial points which remain. (auth)

16012 (BMI-X-329) CORRCSION PROTECTION OF THE HYDROFLUORINATOR BY AN INERT GAS SPARGE. P. D. Miller, L. K. Matson, and E. F. Stephan (Battelle Memorial Inst., Columbus, Ohio). Feb. 5, 1965. Contract W-7405-eng-92. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Several experiments were conducted to determine if an inert gas sparge just below the surface of the liquid would reduce the severe attack at the interface by diluting the HF in this area. In these experiments, the 52-37-11 mole % $NaF-LiF-ZrF_4$ salt with HF sparge was used at 650°C in 4-inch Hastelloy B and 2-inch INOR-8 containers with INOR-8 corrosion specimens. It was concluded that argon and helium sparge gases definitely reduced corrosion, but the data were inconsistent. Gas flow patterns and other variables may have an effect on the corrosion inhibition. (D.L.C.)

16013 (CEA-R-2600) PROBLEMES DE CORROSION AQUEUSE DE MATERIAUX DE STRUCTURE DANS LES CONSTRUCTIONS NUCLEAIRES. (Some Problems on the Aqueous Corrosion of Structural Materials in Nuclear Engineering). Henri Coriou and Lucien Grall (Commissariat à l'Énergie, Saclay (France). Centre d'Études Nucléaires). Aug. 1964. 71p. Dep.(mn).

A comprehensive view is given of some aqueous corrosion studies which have been carried out with various materials for utilization either in nuclear reactors or in irradiated fuel treatment plants. The various subjects are listed below: (1) Austenitic Fe–Ni–Cr alloys. The behavior of austenitic Fe–Ni–Cr alloys in nitric medium and in the presence of hexavalent chromium. The stress corrosion of austenitic alloys in alkaline media at high temperatures. The stress corrosion of austenitic Fe–Ni–Cr alloys in 650°C steam. (2) Ferritic steels. Corrosion of low alloy steels in water at 25 and 360°C. (3) Zirconium alloys. The behavior of ultrapure zirconium in water and steam at high temperature. (auth)

16014 (CONF-446-81) EVALUATION OF MILD STEEL IN THE HEAVY WATER COMPONENTS TEST REACTOR. J. Malvyn McKibben (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). [1963]. Contract AT(07-2)-1. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The performance of mild steel in the HWCTR has been satisfactory. No equipment failures or operating problems have resulted from its use, and corrosion measurements indicate that failure of equipment by corrosion is not likely in the forseeable future. To achieve satisfactory performance, protective oxide films should be formed on the equipment prior to nuclear operation, and favorable chemical conditions should be maintained, i.e., alkaline water and very low concentrations of dissolved oxygen. (auth)

16015 (EURAEC-1322) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 2. B. N. Ferry (Virginia Polytechnic Inst., Blacksburg). Dec. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3208. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The construction of an electroplating unit and a nitriding furnace with a new gas purification system is reported. Some nitriding experiments with Type 304 stainless steel wires are described. (D.L.C.)

16016 (HW-84281(p.5.1-5)) ENVIRONMENTAL EFFECTS. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation.

Corrosion rates were measured for Zr alloys exposed one ETR cycle, 16 days, to 280°C G-7 Loop coolant with H_2 additions. The O_2 concentration in the coolant is estimated to have been 0.1 ppm or less, rather than about the 0.8-ppm typical of operation without the H_2 additions. Corrosion rates in the hydrogenated water are less than previously reported, particularly at the lower flux levels. However, even in hydrogenated water rates are higher than observed out-of-reactor. Rates are about the same for Zircaloy-2, Zircaloy-4, and Zr–3 wt % Nb–1 wt % Sn. No effect of cold work on corrosion was observed. Metallography and H_2 analyses on the irradiated samples remain to be completed. Samples irradiated 264 days in ETR G-7 Loop were examined metallographically. Oxide film thickness generally confirms earlier results on long-exposure samples but suggests film growth is greater normal to the rolling plane than on lateral surfaces. H_2 pickup fractions ranged from 40 to 85%. (auth)

16017 (HW-84281(p.5.6-25)) ATR GAS LOOP SUPPORT. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation.

Oxidation of Hastelloy X-280 and Haynes Alloy 25 in O_2 at 1121°C can be described as proceeding by two consecutive parabolic processes. A dependence of Hastelloy X-280 oxidation rates on the $\frac{1}{5}$ power of O_2 pressure was established. Though corrosion rates for Haynes Alloy 25 apparently increase slightly with O_2 pressure the data scatter prevented quantitative interpretation. Exposure of Hastelloy X-280 and Haynes Alloy 25 to CH_4 at 1121°C resulted in carburization. Carburization rates depend on diffusion of CH_4 through the H_2 produced by CH_4 decomposition at the sample surface. The Dynamic Materials Testing Apparatus is operating at 1121°C with He velocities of 500 fps at 350 psi through the test section. A sample of Haynes Alloy 25 exposed to contaminated He for 4 days oxidized at rates comparable to those in pure static O_2 at 20 μ, about 0.3 mils in 4 days. The corrosion product was largely spalled from the sample suggesting an efficient filtering system will be required in the ATR Gas Loop. Corrosion studies of Mo and TZM alloy in O_2 at 1000°C are largely complete. Metal penetration rates were measured as a function of O_2 pressure. Serious internal oxidation noted in photomicrographs may be due to subsurface defects in the samples. Equipment necessary to extend the studies to higher temperatures is in process of installation. Reconstruction of the gas chromatograph with all valves and mechanical connections placed inside a He-purged box has greatly improved chromatograph operation. The rebuilt instrument is sensitive to less than 1 ppm of H_2, O_2, N_2, CH_4, CO, CO_2, Ne, Ar, Kr, Xe. Ne and H_2 appear resolvable, but Ar and O_2 are not separated at room temperature. The emf generated by differential O_2 partial pressures across a $ZrO_2-7\frac{1}{2}$% CaO solid electrolyte appears to be the basis of a practical O_2 analysis over a very wide concentration range. An O_2 probe was built on this principle. Periodic chromatographic analysis of the He from the Metallurgy Research Model Gas Loop was made during startup. Rapid buildup of H_2, CO, and CO_2 occurred, presumably the result of reaction of moisture with hydrocarbon contamination. O_2 dropped below the detection limit of 0.1 ppm. (auth)

16018 (HW-84281(p.5.26-30)) PRP MATERIALS DEVELOPMENT. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation.

Metallographic examination of sections of three discharged PRTR process tubes generally confirms the 5X in-core corrosion acceleration factor for Zircaloy-2 previously reported. A dummy fuel rod supporting Zircaloy-2 and Zircaloy-4 sheathing tube samples was attached to a 19-rod fuel element and charged in PRTR. Examination after 700 hr confirms satisfactory operation of the sample assembly and maximum corrosion rates for centrally located corrosion rings. The significance of thermal cycling on Zircaloy corrosion in 425°C, 23-torr water vapor was evaluated. The result apparently is a higher, linear, terminal oxidation rate. (auth)

16019 CORROSION OF LOW-ALLOYED STEELS IN DEMINERALIZED WATER AT 25°C AND AT 360°C. EFFECT OF OXYGEN. H. Coriou, L. Grall, M. Pelras, and A. Perez (Centre d'Etudes Nucleaires, Saclay, France).

Corrosion Anti-Corrosion, 12: 358-70(Dec. 1964). (In French)

The effect of the oxygen concentration in the demineralized water on the corrosion of low-alloyed steel was studied. Comparative tests were made on soft steels, low-alloyed steels, and 18/10 stainless steel in water at 25 and 360°C in the presence and absence of oxygen. The principal results were defined by the morphological study of the oxide layers and determination of their nature. It was concluded that the soft steel would be difficult to use in nuclear reactors because of the significant differences of corrosion that it undergoes as a function of the presence of oxygen and temperature variations. Low-alloyed steels containing at least 4% Cr seemed to have corrosion properties, which make them suitable for use in reactors. (tr-auth)

16020 STRESS-CORROSION SUSCEPTIBILITY AND THE DISLOCATION ARRANGEMENTS OF AUSTENITIC STAINLESS STEELS. K. C. Thomas, R. Stickler, and R. J. Allio (Westinghouse Electric Corp., Pittsburgh). Corrosion Sci., 5: 71-9(Jan. 1965). (WCAP-5394)

The dislocation arrangements in 304 stainless steel and Incoloy 800 were determined as a function of temperature and strain. Dislocation pile-ups were observed in both alloys in spite of the fact that the stacking fault energies were considerably different, viz. < 16 erg/cm^2 for the 304 stainless steel and > 30 erg/cm^2 for the Incoloy 800. The stress-corrosion behavior of the two alloys in magnesium chloride boiling at 142°C was determined. The Incoloy 800 was found to be considerably more resistant than the 304 stainless steel. After critically reviewing the current theories of stress corrosion and structural and stress-corrosion data for a series of austenitic alloys, it was concluded that the data could best be correlated with the theory proposed by Swann. According to this theory, the presence of short range order is expected to markedly influence dislocation arrangement and stress-corrosion behavior. A review of the literature revealed that there is some indirect evidence to indicate the presence of short range order in certain of the austenitic alloys, but the evidence is not conclusive. (auth)

16021 A RADIOTRACER STUDY OF THE COMPOSITION AND PROPERTIES OF ANODIC OXIDE FILMS ON TANTALUM AND NIOBIUM. J. J. Randall, Jr., W. J. Bernard, and R. R. Wilkinson (Sprague Electric Co., North Adams, Mass.). Electrochim. Acta, 10: 183-201(Feb. 1965).

The composition of anodic oxide films formed on tantalum in phosphoric and sulfuric acids and on niobium in phosphoric acid was determined by the use of ^{32}P- and ^{35}S-labeled electrolytes. The films consisted in all cases of a layer of stoichiometric pentoxide next to the metal and an outer layer characteristic of the anodizing electrolyte. This layered structure could only arise through the movement of both cations and anions during the growth of the film. The amount of a particular species incorporated into the film from the electrolyte increased with increasing solution concentration and current density and decreased with increasing temperature; variations in the amount of included material with temperature were entirely accounted for by changes in the relative contributions of cation and anion movement during film growth. It is shown that differences between films formed in phosphoric and sulfuric acids are due to the much larger degree of incorporation that occurs with the former. The incorporation of phosphorus into the oxide results in a decrease of dielectric strength. (auth)

16022 CORROSION STUDIES ON REACTOR MATERIALS BY HIGH-TEMPERATURE AND HIGH-PRESSURE WATER LOOP. II. CHEMICAL INVESTIGATIONS OF THE WATER IN HIGH-TEMPERATURE AND HIGH-PRESSURE WATER LOOP. Hiroharu Itami, Sueo Nomura, Cho Akutsu, and Noboru Ito (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 15-24 (Jan. 1965). (In Japanese)

Studies were carried out at 260 and 280°C, using an out-of pile stainless-steel water loop. Emphasis of the study was placed on the effect of dissolved oxygen on the formation of soluble corrosion products and insoluble crud in the water. The concentrations of both soluble corrosion products and insoluble crud increased with the dissolved oxygen concentration. The particles of the insoluble crud caught in a 320-mesh filter in the loop purification system were blackish-brown platelets 50 to 100 μ across. They were separated into magnetic and nonmagnetic fractions; through x-ray diffraction, the former was found to be mainly Fe_3O_4 and the latter ZrO_2. It was observed that there was little relation between the composition of the crud and that of the main materials constituting the loop. The insoluble crud deposited more readily on 18-8 stainless-steel than on Zr alloy test specimens. The ionic forms of the elements in the soluble corrosion product were estimated from chemical analysis of the ion-exchange resin discarded from the loop water purification system. (auth)

16023 INHIBITION OF CHLORIDE STRESS CORROSION CRACKING OF AUSTENITIC STAINLESS STEEL. C. R. Bergen (Allis-Chalmers Mfg. Co., Greendale, Wis.). 20p. (CONF-654-49)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Surface treatment techniques for inhibiting stress-corrosion cracking of austenitic stainless steels are discussed in the light of a proposed mechanism for stress-corrosion cracking. Criteria for selecting stress-corrosion inhibitors were developed. Several inhibitors selected on the basis of this criteria were tested. The inhibitors were applied as surface treatments on Type 304 stainless steel U-bends. Time to cracking improvements of fifty to several hundred per cent were found with very limited amounts of the inhibitors present. (auth)

Fabrication

Refer also to abstracts 15540, 15662, 15780, and 16189.

16024 (AD-425058) FABRICATION CHARACTERISTICS OF 8Al-1Mo-1V TITANIUM ALLOY. Gorman Morris (McDonnell Aircraft Corp., St. Louis, Mo.). Nov. 12, 1962. AF33(657)-11215. 97p. (A-248). $8.60 (CFSTI).

Investigation was conducted to determine the fabrication characteristics of 8Al-1Mo-1V titanium alloy. The following tests were conducted: (a) Room temperature mechanical properties of 0.022-inch sheet and 0.063-inch sheet; (b) Uniform elongation properties of 0.22-in. sheet at 78, 400, 800, 1200, and 1400°F; (c) Minimum bend radius of both the 0.022-in. sheet and the 0.063-in. sheet; (d) Fusion welding characteristics of 0.063-in. sheet; (e) Resistance spot welding characteristics of both the 0.022-in. sheet and the 0.063 in. sheet; (f) Contour flange forming characteristics of 0.063-in. sheet; (g) Dimpling characteristics of both the 0.022-in. sheet and the 0.063-in. sheet; and (h) Cleaning characteristics. (OTS)

16025 (AD-425218) ULTRASONIC WELDING OF SELECTED REFRACTORY METALS AND ALLOYS. Final Report. Research Report No. 63-54. (Aeroprojects, Inc., West Chester, Pa.). June 1963. Contract NOw 61-0410-c. 95p. $9.10(CFSTI).

Investigations with thin gages of molybdenum-0.5% titanium alloy, niobium-10% Titanium-10% molybdenum alloy, and tungsten showed that these materials are susceptible to ultrasonic welding, and that the strength decay of such ultrasonic welds at 2000°F is not appreciably greater than that of the parent sheet material. Weld cracking tendencies in some instances were attributed primarily to material contamination and in other instances to non-uniform material quality. It was postulated that improved weld quality can be obtained by strict control of material quality and by the use of programmed ultrasonic power and clamping force. (auth)

16026 (BBC-TR-382-243) DEVELOPMENT OF VERY-HIGH-STRENGTH BERYLLIUM WIRE. Final Report. E. A. Murphy and R. G. O'Rourke (Brush Beryl-

lium Co., Cleveland, Ohio). Dec. 7, 1964. Contract NOw-64-0162-c. 57p.

The results of a program directed toward development of a process to produce high-strength beryllium fine wire are described. The beryllium–iron alloys could not be deformed at temperatures used for the warm drawing technique. It was found that the 2% copper level gives improved mechanical properties to extruded forms over the 5% copper level. Both copper–beryllium alloys showed very poor strain hardening characteristics during the warm drawing operation. The drawability of the fine grained materials from the same starting material was found to decrease with decreased grain size with increased oxide content. A 15% increase in tensile strength with a substantial increase in wire ductility at 0.00477-inch diameter was shown for wire, as-drawn from 0.210-inch diameter, from starting material having –20 +10 micron particle size. Similar strength levels with excellent ductility were obtained with high purity –15 +1 electrorefined material at wire sizes of 0.001278-inch diameter. A 25% increase in tensile strength was obtained after pickling. The data suggest that the optimum tensile strength for wrought beryllium wire would occur at some narrow fractional cut with the minimum particle size well over 1 micron at a high purity level. This would permit maximum work hardenability while still retaining grain size control. (auth)

16027 (CEA-R-2618) UTILISATION DU VANADIUM DANS LA FABRICATION DE CRYOSTATS ET FOURS POUR EXPERIENCES DE NEUTRO-CRISTALLOGRAPHIE. (Use of Vanadium in the Production of Cryostats and Ovens for Neutro-Crystallographic Experiments). Pierre Meriel and Olivier Testard (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Oct. 1964. 10p. Dep.(mn).

The scattering of neutrons by vanadium is incoherent, and thus this metal is of great interest in the construction of cryostats and ovens. As no diffusion peak is expected at finite angles, the use of vanadium prevents use of the different techniques with other materials. Thin vanadium tubes have been manufactured which can be soldered or brazed on other metals or alloys. Several techniques of soldering, brazing, etc., are given, with which nonbrittle, leakfree joints were obtained. A cryostat designed to operate at 4°K and an oven operating between 50°C and 1000°C with a very low thermal gradient are described. (auth)

16028 (CEA-R-2634) JONCTIONS DIFFUSEES ZIRCALOY 2–ACIER INOXYDABLE. (Diffused Zircaloy 2/Stainless Steel Junctions). Francois Jacques (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Jan. 1965. 62p. Dep.(mn).

The diffusion permits one to realize joints between two different materials, in fact of the formation of a liquid phase at the contact face. The study of the tensile properties allowed the determination of the ideal conditions for the diffusion treatment which are, within 2 and 3 minutes for a temperature within 1020°C and 1030°C. The characteristics of the obtained joints were studied: mechanical properties, tightness, resistance to thermal cycling. Analysis of the thermal stress, owing to the differential dilatation of the two materials was the object of a particular study. The investigation of the diffusion zone includes especially an analysis of the constituent distribution formed during the diffusion treatment. (auth)

16029 (DMIC-209) SECOND STATUS REPORT OF THE U. S. GOVERNMENT METALWORKING PROCESSES AND EQUIPMENT PROGRAM. F. C. Holden and F. W. Boulger (Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio). Nov. 23, 1964. Contract AF33 (615)-1121. 41p.

Summaries are presented of progress on the research programs in the area of manufacturing-method technology involving metal-deformation processing. The summaries cover the following subject areas: deformation and fracture; strain rate and temperature effects; high-pressure studies; ultrasonic effects; orientation and texture studies; grain-size effects; friction, wear, and surface-effect studies; mechanics of processing; superplasticity; and metalworking process development. (D.L.C.)

16030 (MLM-1163(p.G.1-7)) DIALLYL PHTHALATE MOLDING POWDERS. L. W. Hartzel (Mound Lab., Miamisburg, Ohio).

The polymerization of diallyl phthalate with peroxide results in an unsaturated prepolymer which is used as a molding powder. The ingredients which are added to the powder to improve its properties are described. Methods for testing powder batches are considered, and a sophisticated method using an extrusion rheometer is described in some detail. The effects of orifice type and temperature on the pressure-time curves obtained with this method, are shown. (D.L.C.)

16031 (SSD-TDR-63-196) HOT-PRESSING OF TUNGSTEN POWDER. J. E. White and M. M. Jurkowitz (Aerospace Corp., El Segundo, Calif.). Aug. 22, 1963. Contract AFO4(695)-269. 38p. (AD-424203). $4.60(CFSTI).

A hot-pressing study was conducted on three grades of tungsten powder to delineate the effect of a dispersed second phase and initial powder particle size on the hardness, density, and grain size of the final product. Hot-pressing was conducted in ATJ graphite dies under pressures up to 8000 psi and at temperatures from 1400 to 1800°C. Holding time at temperature and pressure ranged from 30 minutes to 2 hours. The pellets were pre-cold pressed to 55% theoretical density. The formation of the tungsten-carbide case, inherent for hot-pressing in graphite, was followed as a function of time, temperature, pressure, and initial powder particle size. Grain growth and dispersed phase stability of hot pressed tungsten were evaluated. (auth)

16032 (AEC-tr-6541) THE INFLUENCE OF LUBRICATING MEDIA ON THE ULTIMATE SHEAR STRESSES DURING DRAWING OF METALS. A. A. Kanaev and S. Ya. Veiler. Translated by J. F. White (General Electric Co., Advanced Technology Services, Cincinnati), from Dokl. Akad. Nauk SSSR, 159: 541-3(1964). 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

The role of lubrication in the drawing of wire is discussed. An experimental study was made of the effects of deforming metal layers and lubrication media on the drawing rate vs stress relation for Cu and Mo. The resistance to shear in the surface layer is discussed. (D.L.C.)

16033 PREPARATION OF NUCLEAR FUELS CONSTITUTED OF THE CERAMIC UO_2–ThO_2. Maria Lucco Borlera (Istituto di Chimica Generale e Applicata e di Metalurgia del Politecnico, Turin). Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 968-76(1963-64). (In Italian)

Ceramic fuel elements of UO_2–ThO_2, with phosphoric anahydride in an optimum quantity of the order of 0.4 to 0.5% as compacting agent, were prepared by sintering. Addition of corresponding quantities of previously sintered P_2O_5–TiO_2 mixtures was shown to be especially favorable. The results are discussed and compared with those obtained by other sintering techniques. (tr-auth)

16034 ELECTRODEPOSITION OF COHERENT DEPOSITS OF REFRACTORY METALS. I. NIOBIUM. G. W. Mellors and S. Senderoff (Union Carbide Corp., Parma, Ohio). J. Electrochem. Soc., 112: 266-72(Mar. 1965).

A general method was found for the electrodeposition of coherent, dense deposits of refractory metals by electrolysis of molten salts. By dissolving the refractory metal fluoride in mixtures of alkali metal fluorides, coherent thick coatings of chromium, hafnium, molybdenum, niobium, tantalum, tungsten, vanadium, and zirconium may be deposited. Not only do the deposits in all cases have the theoretical density, but in most cases are extremely pure and equal to or better in mechanical properties than electron-beam-melted material available commercially. While differences existed from metal to metal in the details of the compositions of the electrolyte and the valence state of the refractory metal, the general

process is described in terms of one of the first metals studied, niobium. Niobium metal was electrodeposited from a solution of about 10 wt % NbF_5 in a mixture of alkali fluorides at a temperature of about 775°C and a current density of about 50 ma/cm² with commercially pure niobium as anode material. Anode and cathode efficiencies were close to 100% and deposits with hardness of 85 to 100 DPH were obtained. Deposits with densities of 99.8% of theoretical and higher were obtained and the throwing power of the bath was better than that usually associated with commercial nickel plating. There was no major restriction on substrates, since steel, stainless steel, graphite, copper, Hastelloy alloys, and others were used. Thicknesses up to ¼ in. were electrodeposited with a surprisingly smooth surface. The microstructures of the deposits were the typical columnar grain structure usually observed in electrodeposits without addition agents and their soundness was confirmed by mechanical testing. Also, successful electrorefining was accomplished. (auth)

16035 ELECTROLYTIC CAPACITOR ANODES DERIVED FROM TANTALUM–TITANIUM AND NIOBIUM–TITANIUM ALLOYS. Thaddeus L. Kolski (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). J. Electrochem. Soc., 112: 272-9(Mar. 1965).

Porous sheets of tantalum or niobium can be prepared by volatilization of titanium from sheets of tantalum-titanium or niobium-titanium alloys at high temperatures in vacuum. Removal of titanium from the initial alloy resulted in significantly increased surface area, nearly all of which was available for anodic film formation. Conventional anodization of material prepared in this manner produced anode-dielectric systems of excellent quality. Pore dimensions within the porous anodes were large with respect to anodic film thickness, and formation to 600 v could be achieved with only minor loss of effective anode area. (auth)

16036 VAPOR DEPOSITION OF GERMANIUM ON MOLYBDENUM. I. L. Kalnin and J. Rosenstock (American-Standard Research Div., New Brunswick, N. J.). J. Electrochem. Soc., 112: 329-33(Mar. 1965).

The vapor deposition of germanium on single and polycrystalline molybdenum substrates by hydrogen reduction of $GeCl_4$ vapor was studied as a function of deposition temperature (600 to 950°C), $GeCl_4$ concentration (0.2 to 4 mole %) and total gas flow (200 to 600 cc/min). The activation energy of this process was 12 kcal/mole. A multiphase intermediate region containing several molybdenum germanides was found between the Mo and the polycrystalline Ge deposit. The molybdenum germanide phases were identified by x-ray diffraction and delineated by sectioning and selective etching. Their microhardness, electric resistivity, and adherence were investigated. (auth)

16037 THE CLADDING OF URANIUM FUEL ELEMENTS FOR THE SWISS MATERIALS-TESTING REACTOR DIORIT. E. A. Bloch (Swiss Aluminium Ltd., Neuhausen am Rheinfall, Switzerland). J. Inst. Metals, 93: 196(Feb. 1965).

A method was developed for canning uranium bars for the heavy-water-moderated, materials-testing reactor DIORIT. The canning material is commercially pure aluminum. The method is described and shown schematically. (M.C.G.)

16038 SIGNIFICANCE OF POWDER METALLURGY FOR DEVELOPMENT AND PRODUCTION OF NEW TYPE NUCLEAR FUEL. MANUFACTURE OF NUCLEAR FUEL PARTICLES, COATED WITH GRAPHITE. F. Benezovskii. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 4, 104-11 (1964). (In Russian)

Protection against air oxidation of nuclear fuel powder pellets of UC_2 and ThC_2 by graphite coating of the pellets in a carbon-lined fluid bed reactor, using Ar or He as gas carriers and methane or acetylene as the gases producing pyrographitic coating from 2200 to 2600°C was investigated. Production technology of UC_2–ThC_2 pellets by powder metallurgy prior to graphite coating is discussed. A schematic design of the fluid bed reactor for graphite coating and cross sections of nuclear fuel pellets coated by graphite films is included. (Rev. Metal. Lit., 21: Dec. 1964)

16039 SUMMARY REPORT ON THE DEVELOPMENT OF CERAMIC SINTERED CONSTRUCTION MATERIALS, THEIR PROPERTIES, AND RANGE OF APPLICABILITY. K. R. Herrmann. Schweiz. Arch. Angew. Wiss. Tech., 31: 2-29(Jan. 1965). (In German)

The development of ceramic sintered construction material is described, together with a review of the historical relations. The concept of old Chinese porcelain is characterized, and the characteristics of European porcelain are given. The various development steps and modifications of the earlier types of porcelain are described in parallel with a review of developments in technology. A characterization of the following material groups is given individually: historic porcelain, hard and soft porcelain, cordierite ceramics, translucent china, bone china, chemical-engineering porcelain, materials on the basis of Al_2O_3–BeO–CaO–CeO_2–MgO–ThO_2–ZrO_2–SiO_2, lithium and rutile ceramics, celsian porcelain, cermets, electroporcelains, and steatite. The preparation methods, properties, and range of applicability of each group are discussed. The trends in the future development of ceramics, especially improvements in the elastic properties, modifications in the preparation, and development of raw materials, are discussed. (tr-auth)

16040 PREPARATION AND PROPERTIES OF NIOBIUM (COLUMBIUM) STANNIDE ON INSULATING SUBSTRATES. G. W. Cullen (Radio Corp. of America, Princeton, N. J.). Trans. AIME, 230: 1494-9(Dec. 1964).

Niobium-tin intermetallic compounds were prepared on insulating substrates by simultaneous hydrogen reduction of gaseous niobium and tin halides. Stoichiometric material was greater than 98.8% theoretical density, appeared to be single-phase, and had a total impurity level less than 0.3 at.%. Transition temperatures and lattice constants may be related to composition. Typical current densities in various fields and orientations are given. (auth)

16041 DEVELOPMENT OF A (110) PREFERRED ORIENTATION IN ROLLED AND ANNEALED HIGH-PURITY TANTALUM. C. G. Dunn and H. F. Webster (General Electric Research Lab., Schenectady, N. Y.). Trans. AIME, 230: 1567-70(Dec. 1964).

Rolling and annealing procedures are described for developing the (110) preferred orientation in tantalum for use as a thermionic-emission material where electrodes of a uniform high work function are needed. The development of a (110) [001] annealing texture is also reported. A preferential growth process due to low (110) gas-metal surface energy is considered in explanation of the observed growth of (110) grains. (auth)

16042 GROWING LARGE SINGLE CRYSTALS OF NIOBIUM (COLUMBIUM) BY THE STRAIN-ANNEAL METHOD. T. G. Digges, Jr. and M. R. Achter (Naval Research Lab., Washington, D. C.). Trans. AIME, 230: 1737(Dec. 1964).

The strain-anneal technique was used to prepare large-diameter single crystals of niobium. Single crystals were grown from 0.250 in. dia and 12 in. long to 1.00 in. dia and 5 in. long. (M.C.G.)

16043 FABRICATION OF NEPTUNIUM-237 WIRE BY EXTRUSION. R. E. Tate and L. J. Herman, Jr. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 233: 437-8(Feb. 1965). (LADC-6641)

A 0.75-in.-long, 0.26-in.-diameter ingot of ^{237}Np was extruded by the direct process through flat-face orifices to form several sizes of wire ranging from 0.010 to 0.030 in. in diameter. Molybdenum disulfide was used as the die lubricant. The extrusion was carried out in a vacuum of about 10^{-4} torr. (M.C.G.)

16044 THE CEMENTATION OF BORON TO STEELS BY THE METHOD OF ELECTROLYTIC DEPOSITION. M. Kawakami (Tokyo Inst. of Tech.). p.357-64 of STI/PUB/81.

A fabricating method is described for cementation of a control rod with boron. The cementing is carried out by electrolysis of fused borax at about 900°C, the steel rod

to be cemented acting as a cathode and the graphite electrode as an anode. As the electrolysis progresses, boron is deposited on the steel rod and diffused into it. When suitable conditions of electrolysis exist, a case of the steel rod with as much as 20% boron content can be obtained. The kinds of steel investigated were carbon steel, stainless steels, high chrome steel etc., and each showed good results. (auth)

16045 DEVELOPMENT OF BERYLLIUM STRUCTURE FOR SPACE VEHICLES. S. E. Ingels, L. A. Riedinger, and E. H. Schuette (Lockheed Missiles & Space Co., Sunnyvale, Calif.). 32p. (CONF-729-10)

From International Conference on Beryllium, Philadelphia, Oct. 1964

A program for the development of beryllium structures for use in space vehicles is discussed. Tests of mechanical joints and panel-buckling tests demonstrated the practicability of beryllium sheet as a structural material. Experimental studies showed that in an acoustic-vibration environment, beryllium has endurance superior to that of the magnesium alloy that has been in use. However, problems in handling and fabrication were such that great care had to be exercised in choosing an area of use where there was good promise that fabrication technology could be sufficiently advanced to meet the challenge. Skins and doors of the Agena equipment section provided such an area. Each manufacturing step required development and close control of shop techniques. The problems that were encountered, however, were all successfully handled, with the result that manufacture is now routine and scrap rates are gratifyingly low. Probably the outstanding single accomplishment of the program is the successful use of mechanical fasteners for all attachments. (P.C.H.)

16046 ACTIVATED SINTERING IN BERYLLIUM POWDERS BY SELECTIVE ADDITION OF TRACE ELEMENTS. J. W. Butcher and J. N. Lowe (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). 25p. (CONF-729-9)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The relative effects of chemical composition and particle size distribution on the hot compaction characteristics of commercial beryllium powders were investigated, and it was concluded that the powder compactibility was almost entirely dependent on the chemical composition. The addition to particle surface of relatively pure powder obtained from electrolytic flake metal of 500 ppm silicon or the equivalent atomic concentration of other elements, (iron, nickel, chromium) normally found in commercial beryllium increased the length to diameter ratio of above 98% density from <1 to >2. A satisfactory dispersion on the particle surfaces could be obtained by ball milling the activating element with the powder prior to hot pressing. Various models are discussed for the satisfactory distribution of the beneficial element around the particle surface and the effect of the activating elements in the densification process. (auth)

16047 METHOD OF ENCAPSULATING A GRAPHITE BODY CONTAINING METALLIC AND CERAMIC PARTICLES. Mark J. Smith (to Air Reduction Co.). U. S. Patent 3,158,547. Nov. 24, 1964. Filed June 30, 1961.

Methods are described for making fuel elements that consist of a core of compacted graphite powder mixed with particles of nuclear fuel surrounded by an encapsulation of unfueled graphite material. Essentially the methods consist of forming a shell into which the loaded matrix can be inserted, compressing the core and shell to unite their adjacent particles integrally with one another, and heating to remove binder materials. The body can then be ground or machined to exact size and shape without damaging the fuel element. (A.G.W.)

16048 RADIATION SOURCE AND METHOD FOR MAKING SAME. Robert E. Black and Farno L. Green (to General Motors Corp.). U. S. Patent 3,161,504. Dec. 15, 1964. Filed Mar. 31, 1960.

A method for the manufacture of a photon radiation source is described. The radioactive source pellet is a dense sintered mixture of a rare earth radioisotope, which serves as the photon source, and non-radioactive Al or Nb, preferably the former, which serves as the binder. The pellet is made by forming a mixture of Al or Nb powder and a rare earth or rare earth compound, preferably the oxide, pressing the mixture into a powder compact, and then sintering the compact. The rare earth can be irradiated with thermal neutrons to its photon-emitting form either prior to forming the mixture or after the sintering operation. In the preferred form, the concentration of the rare earth is greater in the center portions of the pellet than in surface portions. The photons emitted are within relatively narrow energy levels and approach the ideal of a single energy level emission. (A.G.W.)

16049 APPARATUS FOR CARRYING OUT ELECTROLYTIC TREATMENTS ON THE ENTIRE SURFACE. Louis Facquet, Jacques Daboval, and Guy Chauvin (to Commissariat à l'Énergie Atomique). U. S. Patent 3,161,578. Dec. 15, 1964. Priority date Mar. 22, 1960, France.

An apparatus for electrolytic treatment of the entire surface of an electrically conductive work piece that is substantially a solid of revolution about one axis is patented. The work piece rests freely inside a coil spring supported in a horizontal position by a rod that extends along the entire upper inside surface of the spring. When the support rod is rotated by a motor, friction causes rotation of both the coil and the work piece. The part of the coil containing the work piece is immersed in a bath suitable for carrying out the desired treatment. The inside surface of the coil is electrically conducting and provides electrical contact with the work piece; an electrode for completing the circuit is immersed in the bath. Rotation of the assembly thus permits the entire surface of the piece to be treated without discontinuity. Means are provided for limiting axial displacement of the coil along the support rod and for preventing the work piece from leaving the spring at either end. The apparatus may also be used for carrying out non-electrolytic chemical treatments. It is particularly useful for nickel plating of uranium bars used in nuclear reactors. (A.G.W.)

16050 JOINTING OF REFRACTORY METALS BY SOLID-STATE DIFFUSION BONDING. C. O. Tarr (to U. S. Atomic Energy Commission). U. S. Patent 3,170,234. Feb. 23, 1965.

A method was developed for joining refractory metals in the group consisting of tungsten, tantalum, niobium, molybdenum, rhenium, vanadium, and alloys thereof to themselves and one another by solid-state diffusion bonding. Smooth, oxide-free surfaces of the metals being joined are brought into contact under a protective atmosphere or vacuum at a relatively low pressure and a temperature above 1350°C and below the melting point. In an alternative embodiment a thin refractory metal layer is interposed between the joining surfaces of larger workpieces. Only a minimal pressure is required, and formation of brittle intermetallic compounds at the interface is avoided. (AEC)

16051 METHOD OF MAKING PLUTONIUM MONOCARBIDE. Ross M. Mayfield and William G. Tope (to U. S. Atomic Energy Commission). U. S. Patent 3,170,759. Feb. 23, 1965.

A process was developed producing plutonium monocarbide by heating plutonium in a graphite crucible at between 1575 and 1650°C for 35 to 60 minutes in a vacuum and cooling to room temperature under vacuum. (AEC)

16052 METHOD OF VITRIFYING CERAMIC COATINGS. M. A. Schwartz (to U. S. Atomic Energy Commission). U. S. Patent 3,170,812. Feb. 23, 1965.

A method was developed for applying a protective ceramic coating to a beryllium carbide-carbon body. An aqueous suspension of a frit is placed on a body to be coated, the coated body is then heated by radiant means until a portion of the frit melts, covering the body, and the resulting covered body is then heated by induction until the coating is completely melted. (AEC)

Properties and Structure

Refer also to abstracts 15729, 15841, and 17202.

16053 (AD-424622) RELAXATION EFFECT DUE TO DISLOCATIONS IN NIOBIUM AND TANTALUM. Final Technical Report No. 2, December 1, 1961–August 31, 1963. Piero G. Bordoni (Istituto Nazionale di Ultracustica, Rome (Italy)). Sept. 1, 1963. 116p.

The same experimental technique used in previous work on fcc and bcc metals, was employed to investigate the influence of thermal and mechanical treatments and of the hydrogen content on the relaxation effect already found in niobium and tantalum (FTR No. 1). The dissipation coefficient Q^{-1} was measured for several specimens of both metals having the shape of thin, circular plates. In addition to the mechanical measurements, the electric resistivity was also measured on the same materials at several temperatures between 0 and 100°C. From these measurements, the resistivity at 25°C was obtained with a considerable accuracy. It was found that the hydrogen contained in niobium and tantalum is substantially removed by a thermal treatment above 900°C, which also cancels every trace of the relaxation effect. After such a treatment, the material is in a state which seems to be independent of its previous history and can therefore be taken as a reference state. The value of the dissipation coefficient in this state is of the order of 10^{-5}. (OTS)

16054 (AEET/CD/27) STUDIES OF THE ELECTRICAL PROPERTIES OF URANIUM OXIDES. III. ROOM TEMPERATURE MEASUREMENTS OF THE HALL COEFFICIENTS OF α- AND δ-U_3O_8. Nirmal Singh and M. D. Karkhanavala (Atomic Energy Establishment, Trombay (India)). 1964. 7p. Dep.(mn).

Hall coefficient measurements at room temperature on sintered specimens of alpha-U_3O_8 and delta-U_3O_8 are reported. The effective number of conduction electrons are calculated to be 1.3×10^{14} and 5×10^{14} cm^{-3} while the Hall mobility was found to be 0.79 and 0.49 cm^2 $volt^{-1}$ sec^{-1} respectively for alpha and delta-U_3O_8. (auth)

16055 (AEET/Met.-2) METASTABLE PHASES IN URANIUM ALLOYS WITH HIGH SOLUTE SOLUBILITY IN THE B.C.C. GAMMA PHASE. PART I. THE SYSTEM U–Nb. K. Tangri and D. K. Chaudhuri (Atomic Energy Establishment, Trombay (India)). 1964. 42p. Dep.(mn).

Composition limits of metastable phases α', α'', and γ^0 and changes in parameters a, b, c, and angle γ (ab) of the alpha uranium lattice with increasing niobium additions, were determined. While parameter a is not affected sensibly, the parameters b and c steadily decrease and increase respectively. The angle γ shows an abrupt change from 90° at 10.00 at.% Nb to 91.07° at 11.93 at.% Nb. From a study of the effect of cooling rates in producing alternative structures, it is shown that the mode of formation of α', α'', and γ^0 in the U–Nb system is similar to that observed in the U–Mo system. Based on the size of the solute atom, a relationship is developed to predict the α'/α'' boundary composition in various uranium binary systems with high solute solubility in the gamma phase. (auth)

16056 (AEET/Met.-3) METASTABLE PHASES IN URANIUM ALLOYS WITH HIGH SOLUTE SOLUBILITY IN THE B.C.C. GAMMA PHASE. PART II. THE SYSTEM U–Ru. K. Tangri, D. K. Chaudhuri, and C. N. Rao (Atomic Energy Establishment, Trombay (India)). 1964. 23p. Dep.(mn).

In U–Ru alloys containing up to 9.51 at.% Ru, the metastable phases α' and γ^0 produced on water quenching from the gamma field were studied by x-ray diffraction and metallography. For compositions up to 6.90 at. % Ru, only α' phase is produced, whereas for higher compositions (up to the solubility limit of 10 at. % Ru) both the phases α' and γ^0 co-exist. The absence of the phase α'', which is found to exist in the U–Mo and U–Nb alloys, may be ascribed to the incompressibility of the b parameter below 5.80 Å, which may be due to the possible variation in the state of ionization of the ruthenium atoms when present in varying amounts in the uranium matrix. A possible explanation for the co-existence of the phases α' and γ^0 is that the γ^0 phase which requires more than 10 at. % ruthenium for its formation will be present as small incoherently diffracting nuclei in the gamma phase and that these nuclei will grow into larger domains depleting partly the ruthenium content of the surrounding regions, thus rendering them more susceptible to shear producing the phase α'. (auth)

16057 (AGN-8131) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, October 1–December 31, 1964. C. R. Fisher and P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). Jan. 1965. Contract AT(04-3)-368. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The condensing heat transfer apparatus and its planned operation for the studies on Cs, K, and Rb are described. Progress on the thermophysical property measurements is reported. The thermal expansion coefficient of Nb–1% Zr was measured at 75 to 1890°F. The thermal conductivity of vapors and its measurement are discussed. (D.L.C.)

16058 (A1-64-5) SOLUBILITY AND DIFFUSION STUDIES OF ULTRA PURE TRANSITION ELEMENTS IN ULTRA PURE ALKALI METALS. Quarterly Report No. 2, September 29–December 28, 1963. R. L. McKisson, R. L. Eichelberger, and G. R. Argue (Atomics International, Canoga Park, Calif.). Feb. 7, 1964. Contract NAS3-4163. 21p.

The environmental test system under construction consists of a five-chamber unit in which each chamber with its vacuum system is separated from its neighbors by high vacuum valves. The chambers and appurtenances within the chambers will be made of stainless steel. Sample handling within the chambers will be carried out with manipulators under a nominal vacuum of 10^{-6} Torr. The electrochemical machining technique appears capable of preparing single-crystal crucibles having an undisturbed crystalline inner surface condition. The double layer capacitance method of measuring the true surface area of metals has been tested on mercury, electropolished platinum, and tungsten. The outgassing furnace design is complete and construction has begun. A strip heater made from thin tantalum sheet is employed and a minimum of ceramic insulation is used in the hot zone of the furnace. The test capsule heater design is complete. This furnace has a clam-shell design to allow the test capsule to be quickly moved from the furnace hot zone to its quench block position at the end of an experiment. These heating elements are made of thin tantalum sheet and use a minimum of electrical insulation in the hot zone. Chemical analysis studies have been delayed. (D.L.C.)

16059 (ANL-6900(p.203-20)) HIGH-TEMPERATURE REACTOR MATERIALS DEVELOPMENT. R. K. Edwards (Argonne National Lab., Ill.).

A program for the study of high temperature reactor materials is being conducted to build up a reservoir of basic data which may be used for screening and evaluation. The study will be concerned with the chemical stability of potential high temperature fuels, i.e., uranium oxides, phosphides, sulfides arsenides, nitrides, and their solid solutions; and their reactions with H_2 and its contaminants and with refractory structural materials, such as W, Re, Mo, Ta, and various alloys. These studies are planned to yield thermodynamic and phase diagram information. Selected systems are to be investigated in an integrated way using five methods which are mutually supporting. The total vapor pressure of U-bearing species over a two-phase system composed of liquid U (saturated with solid UO_2) plus UO_2 solid (saturated with liquid U) was measured. The total pressures are higher than for pure UO_2. Measurements of the relative concentrations of vaporizing species were carried out for the same two-phase system noted above and also for stoichiometric UO_2. Tentative calculations based on the two sets of data show that the O_2 activity for solid UO_2 is reduced by a factor of 40 to 50 as it becomes substoichiometric. A value of 137.1 kcal/mole was ob-

tained for the heat of sublimation of stoichiometric UO_2. This value is in good agreement with literature values, but it is subject to a possible error of 0.6 kcal/mole because of an incomplete temperature calibration. The extension of the vapor pressure measurements to higher temperatures than those possible in the effusion measurements is to be carried out by use of the transpiration method. Most of the equipment for the work was assembled. Studies of the U–UO_2 system showed that a wide two-liquid immiscibility gap exists at elevated temperatures. The monotectic composition occurs at an O_2-to-U ratio of approximately 1.30. An approximate phase diagram for the U–UO_2 system is presented. W metal of high density was shown to be compatible with both solid and liquid US. There appears to be very little, if any, solubility of the sulfide in W but a detectable solubility of W in sulfide. (J.R.D.)

16060 (AROD-4434:2) THE STRUCTURE AND ANNEALING BEHAVIOR OF EXPLOSIVELY SHOCKED MgO CRYSTALS. Final Report. Mark J. Klein (Battelle Memorial Inst., Columbus, Ohio). Jan. 5, 1965. 13p.

The structure of explosively shocked magnesium oxide single crystals was investigated. Although ionic crystals with the rock-salt structure, such as MgO have been used as models to study the basic processes involved in plastic flow at low deformation rates, little is known about their response to high-velocity deformation. In this investigation, the structural changes induced in MgO crystals by plane shock waves were studied by etch-pit metallography and by electron-spin resonance. The experimental shock-loading procedures were designed to induce high dynamic pressures in MgO crystals for subsequent structural studies. (auth)

16061 (BMI-X-10113) LONG-TERM CREEP RUPTURE OF SINTERED ALUMINUM POWDER AND ZIRCALOY-2 ALLOYS. Summary Report. Relative to USAEC/AECL Cooperative Program. John A. VanEcho and Stanley W. Porembka (Battelle Memorial Inst., Columbus, Ohio). Jan. 25, 1965. Contract W-7405-eng-92. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tests to determine creep properties to at least 20,000 hours were conducted on M-583, M-257, SAP-915, and SAP-895 sintered aluminum-powder materials at 700, 800, and 900°F. These materials proved sensitive to environmental changes and notches, lacked ductility, and did not exhibit third-stage creep. Elongation after rupture in most cases was limited to 4 per cent and reduction of area to about 10 per cent. Some of the SAP-895 and SAP-915 specimens displayed negative creep, one exhibiting a maximum strain at about 3400 hours of 0.647 per cent and a total strain of 0.575 per cent when the test was discontinued at 22,142 hours. Density changes resulting from further sintering or transformation of the dispersed phase from gamma to alpha alumina might be associated with the phenomenon. Creep tests of annealed and 15 per cent cold-worked Zircaloy-2 were carried out at 450 to 750°F, in two cases for times in excess of 50,000 hours. Effects of cycling temperature and cycling both temperature and stress were also studied. At 550°F, the cold-worked material had about twice the creep-rupture strength of annealed Zircaloy-2. At 750°F, the strength differences were slight. Both types of cycling accelerated creep; the temperature cycling had the greater effect. (auth)

16062 (CEA-R-2446) CONTRIBUTION A L'ETUDE DE LA DIFFUSION DES PRODUITS DE FISSION DANS L'URANIUM (theses). (Contribution to the Study of the Diffusion of Fission Products in Uranium (thesis)). Jean Tournier (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires. Oct. 1964. 40p. Dep.(mn).

A simple method was developed for determining the diffusion constants and the solid-state solubilities of a metal which is volatile and only slightly soluble in second metal. This method was applied to the behavior of certain fission products in γ uranium: strontium, barium, lanthanum, samarium, and cerium. This work made it possible to show the effect of the atomic radius of the solute on the diffusion constants. (auth)

16063 (CEA-R-2584) ALLIAGES D'URANIUM A FAIBLE TENEUR POUR ELEMENTS COMBUSTIBLES. (Low-Content Uranium Alloys for Nuclear Fuels). Henri Aubert and Jacqueline Laniesse (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Aug. 1964. 50p. Dep.(mn).

A description is given of the structure and the properties of low-content alloys containing from 0.1 to 0.5 per cent by weight of Al, Fe, Cr, Si, Mo, or a combination of these elements. A study of the kinetics and of the mode of transformation made it possible to choose the most satisfactory thermal treatment. An attempt was made to prepare alloys suitable for an economical industrial development having a small α grain structure without marked preferential orientation, with very fine and stable precipitates as well as a high creep resistance. The physical properties and the mechanical strength of these alloys are given for temperatures of 20 to 600°C. These alloys proved very satisfactory when irradiated in the form of normal size fuel elements. (auth)

16064 (CONF-651-43) OSCILLATORY MAGNETOMORPHIC BEHAVIOR IN THE ELECTRON TRANSPORT EFFECTS OF A Cd SINGLE CRYSTAL AT LOW TEMPERATURES. J. M. Reynolds, K. R. Efferson, C. G. Grenier, and N. H. Zebouni (Louisiana State Univ., Baton Rouge). [1964]. Contract [AT(40-1)-3087]. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Measurements of the Hall effect and magnetoresistance in a cadmium crystal as well as a study of the oscillatory behavior of the thermomagnetic effects are presented. Oscillations periodic in H were found in all the measured effects. The results of an analysis of the amplitudes and periods of these oscillations are presented. (C.E.S.)

16065 (CONF-650210-1) PRECISE POLE FIGURE MEASUREMENTS ON ROLLED URANIUM SHEET. E. F. Sturcken (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). [Feb. 18, 1965]. Contract AT(07-2)-1. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Application of X-Ray Diffraction in the Atomic Energy Field Meeting, Richland, Wash.

Relative diffraction intensities were measured for 25 poles, hkl, in each of 43 directions for rolled uranium sheet (88% RA, 550-650°C). The data gave excellent proof of the validity of the general tensor which was developed for predicting anisotropic physical properties that result from preferred grain orientation. The data were also used to construct 25 pole figures and 43 inverse pole figures which will in turn be used to test proposed mathematical methods for inversion of pole figures to inverse pole figures and vice versa. The data are exceptionally precise because the absorption factor was constant in the diffraction geometry employed, and because a large number of grains were scanned (3 $in.^2$ or about 10^7 grains) to assure high statistical precision. (auth)

16066 (CONF-650210-2) KOSSEL DIFFRACTION PATTERNS OF A URANIUM SINGLE CRYSTAL. E. F. Sturcken (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab. and Rutgers– The State Univ. of New Jersey, New Brunswick. Materials Research Lab.). Feb. 18, 1965. Contract AT(07-2)-1. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Application of X-ray Diffraction in the Atomic Energy Meeting, Richland, Wash.

Pseudo-Kossel diffraction conics of a uranium single crystal were obtained by the back-reflection divergent-beam method. The conics are sharp because of the high absorption coefficient of uranium, and are large in number because of the low crystal symmetry of uranium. The pseudo-Kossel technique permits resolution of planes of the same form (111, $\bar{1}11$, $1\bar{1}1$, etc), yields high precision (1 part in 10^5) and requires short exposure times (3 minutes). It should be a good technique for studying changes in lattice parameters and anisotropic lattice distortions that result from radiation damage in uranium. (auth)

16067 (EUR-1846.f) INFLUENCE DE DIVERS FACTEURS METALLURGIQUES SUR LA FRAGILITE DU MATERIAU COMPOSITE ALUMINUM–ALUMINE. (Influence of Various Metallurgical Factors on the Brittleness of the Composite Aluminum–Alumina). M. Desloire (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1964. 114p. (CONF-704-2). Dep.(mn).

From Proceedings of Fall Metallurgy, Paris, Oct. 1963.

Due to its very interesting physical and mechanical properties, the composite aluminum–alumina is liable to be used in the nuclear reactor as sheathing and structure material. Unfortunately, it possesses a high brittleness at elevated temperature, which is characteristic for such compounds. The influence of the various metallurgical factors on the mechanical properties was studied in order to explain better its behavior. Research has been performed on sintered aluminum of different origins, which has been submitted to various metallurgical treatments: SAP-ISML with different percentages of alumina; sintered aluminum AIAG of fine dispersion; and sintered aluminum ALCOA with very low percentages of impurities. The result of the first tests shows that: (1) The ultimate strength and the elastic limit increase linearly with the amount of alumina while the elongation decreases. (2) The fineness of the alumina dispersion is the leading factor. The elastic limit is reciprocally proportional to the space between the particles, this being in accordance with the theory of OROWAN. (3) The impurities do not influence in an appreciable way the stress-strain curves before the point where reduction in area occurs. On the contrary, iron in the form of $FeAl_3$ particles seems to make the material more brittle at high temperature. (4) SAP with a very low percentage of alumina, submitted to a high rate of hardening and then crystallized to big grains, possesses a high elongation at elevated temperature, while its ultimate strength is little modified. A tentative theoretical interpretation is presented in order to explain the variations of the different properties, such as elastic limit, ultimate strength, percentage elongation, in function of the various studied parameters. (auth)

16068 (EUR-1894.i) RICERCHE SUI METODI DI PREPARAZIONE, SULLA STRUTTURA CHISTALLINA E SULLE CARATTERISTICHE GENERALI DI DIVERSE LEGHE E COMPOSTI DELLE TERRE RARE ED URANIO IN RELAZIONE ALLA LORO UTILIZZAZIONE PER LA MISURA DI PROPRIETA TERMOELETTRICHE. (Research on the Methods of Preparation, the Crystal Structure and the General Characteristics of Various Alloys and Compounds of Rare Earths and Uranium, in Connection with their Use in the Measuring of Thermoelectric Properties). R. Ferro, R. Capelli, Marilisa Mattace-Raso, and Gabriella Rambaldi (Genoa Univ. (Italy). Istituto di Chimica Generale). 1964. 11p. Dep.(mn).

Alloys were prepared of uranium with germanium and of rare earths with Group VIII elements, more especially rhodium, palladium, and platinum. Presented are the results obtained from determination of the crystal structures and in the course of other measurements, more especially of magnetic susceptibility. Also given are observations recorded during the development of apparatus for measuring the thermoelectric efficiency. (auth)

16069 (EUR-2205.f) CONTRIBUTION A L'ETUDE DU SAP FONDU. (Contribution to the Study of Molten SAP). G. Beghi and G. Piatti (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1964. 61p. Dep.(mn).

A study was initiated on the possibility of heating sintered aluminum up to the melting point of the matrix without causing a complete and irreversible destruction of its fine dispersion structure. Various thermal treatments, above the melting point of aluminum, followed by extrusion procedures were carried out on SAP with a nominal percentage of aluminum of 7%. The material thus obtained was studied by aid of different experimental techniques, in particular: metallography, electronic microscopy, x-ray, and mechanical tests. The results obtained enabled a diagram to be made which from the quantitative viewpoint determines the temperatures and times of fusion which are appropriate for not causing any relatively important alterations in the structure of SAP itself. It was suggested to consider the possibility of technological applications which, at first sight, in the case of SAP seemed not to be allowed, e.g., the use of welding methods requiring localized fusions. (auth)

16070 (EURAEC-1075) THE EFFECT OF SMALL ALLOY ADDITIONS ON THE PROPERTIES OF DISLOCATIONS IN α-IRON. D. G. Brandon, R. Anderson, and J. Spreadborough (Battelle Memorial Inst., Geneva (Switzerland)). 1964. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 095-62-12 RDS. 20p. (EUR-1751.e; CONF-640913-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Faraday Society Dislocation in Solids Meeting, Gottingen, Ger.

The temperature and strain rate dependence of the flow stress was measured for Armco iron and its dilute alloys with silicon, chromium, and manganese. The results cannot be accounted for simply in terms of thermally activated dislocation movement through a distribution of rigid potential barriers in the annealed matrix, but require that the workhardening contribution to the flow stress should also be temperature dependent. These results are supported by a thin film electron microscope study of the dislocation structure and dislocation density after deformation at room temperature. Most of the observed effects can be explained if the primary barriers to dislocation movement at low temperatures are interstitial clusters and single interstitial atoms. (auth)

16071 (GE-TM-64-2-8) ENTHALPY AND THERMAL EXPANSION OF SEVERAL REFRACTORY METALS TO 2500°C. J. B. Conway, R. A. Hein, R. M. Fincel, Jr., and A. C. Losekamp (General Electric Co., Cincinnati, Ohio. Advanced Technology Services). [Feb. 1964]. Contract AT(40-1)-2847. 25p. (CONF-524-18). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964.

Enthalpy and linear thermal expansion were measured at temperatures up to 2500°C for the following metals and alloys: W, Re, Ta, Mo, W–25 Re, Mo–50 Re, and Ta–10 W. Experimental methods and equipment are described, and the purity of the materials is tabulated. (D.L.C.)

16072 (HW-84281(p.3.51-8)) PLUTONIUM PHYSICAL METALLURGY. R. D. Nelson, F. E. Bowman, H. E. Kissinger, and B. Mastel (General Electric Co., Richland, (Wash.). Hanford Atomic Products Operation).

The ultimate strength and the yield strength of the beta phase of unalloyed Pu is increased by a factor of three and the ductility is decreased from 400 to 20% if beta-phase is formed from gamma-phase instead of from alpha-phase. Results of experiments on the effect of stress on the beta-to-alpha transformation of Pu indicated that the diffusion of atoms is not a major mechanism for this transformation. The effect of plastic deformation of beta-phase Pu on the kinetics of the beta-to-alpha transformation was determined. The observed increase in induction period and the decrease in rate of transformation is best explained on the basis of a diffusionless transformation. Precision density measurements on Pu at 100 to 115.5°C reveal no discontinuities. If a phase change occurs in this temperature range, no volume change occurs. It was confirmed that the (020) lies perpendicular to the rolling direction in alpha-rolled Pu and perpendicular to the direction of applied stress in the columnar-grained material obtained by beta-to-alpha transformation under compressive stress. (auth)

16073 (MLM-1163(p.L-1-14)) APPLICATION OF METALLOGRAPHY TO THE STUDY OF PHASE EQUILIBRIA. J. E. Selle (Mound Lab., Miamisburg, Ohio).

Alloying of Pu for use as a reactor fuel is discussed. The advantages of liquid Pu fuel alloys are pointed out, and the phase diagrams of Ce–Cu–Pu and Ce–Pu systems are given. The advantages and disadvantages of solid fuels are also given, and the phase diagram of Pu–Y is shown. Some metallographic techniques used to determine the microstructure of Pu alloys are discussed, and the appearances of various structures in Cu–Pu, Ce–Pu, Ce–Cu–Pu, and Pu–Y alloys are described. (D.L.C.)

16074 (MLM-1163(p.M-1-17)) DETERMINATION OF PHYSICAL PROPERTIES OF MOLTEN ALLOYS. L. J. Whittenberg (Mound Lab., Miamisburg, Ohio).

The viscosities of pure plutonium metal, the Pu–Fe eutectic alloy, and the Pu–Ce–Co eutectic alloy were measured, as well as for several other liquid metals. The viscosity of plutonium at its melting point, 6.0 centipoise, is the largest value recorded in the literature for any pure liquid metal, although the activation energy for viscous flow, 3100 calories per gram-atom, is not unusually large. The viscosity of the Pu–Fe liquid at its melting point, 25 centipoise, is the largest value ever reported for a liquid metal system. Since plutonium, the Pu–Fe eutectic alloy, and the Pu–Ce–Co eutectic alloy are highly viscous molten metal systems, any reactor design incorporating their circulation must consider this aspect of their liquid character. (D.L.C.)

16075 (MLM-1163(p.P-1-10)) AN X-RAY-DIFFRACTION STUDY OF PLUTONIUM-BEARING GLASSES. R. J. DeSando (Mound Lab., Miamisburg, Ohio).

The principles of the x-ray diffraction method for studying the structure of noncrystalline substances are discussed. X-ray diffractometric intensity curves were obtained both for the base glass ($Na_2O + SiO_2$) and for 5 and 10% PuO_2 dissolved in glass, and radial electron distribution functions are presented. (D.L.C.)

16076 (NASA-TN-D-2649) GRAIN GROWTH IN DILUTE TUNGSTEN–BORON ALLOYS. Peter L. Raffo (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio); and Robert F. Hehemann (Case Inst. of Tech., Cleveland, Ohio). Mar. 1965. 24p. $1.00(CFSTI).

The grain-growth behavior of arc-melted tungsten and several binary tungsten-boron alloys (0.005 to 0.67 atomic percent B) was studied in the temperature range 3600 to 4200°F. The alloys were prepared by arc-melting sintered electrodes of tungsten and elemental boron powders, followed by extrusion and swaging. Specimens cut from the swaged rod were recrystallized at 3200°F to insure that only grain growth would take place in the subsequent annealing treatments. The grain-growth kinetics were followed by measuring the decrease in grain-boundary surface area β as a function of time at temperature. At 3600 and 3800°F, the decrease in β obeyed a power law of the form $\beta = kt^{-n}$, where t is time and n and k are constants. At 4000 and 4200°F, however, the power law was no longer obeyed because of the onset of discontinuous grain growth. In the latter case, discrete grains in the structure, termed secondaries, consumed the primary grain matrix resulting in the formation of a duplex structure. The incubation period for the onset of discontinuous grain growth increased with increasing boron content. Discontinuous grain growth was postulated to be due to a combination of the dissolution of the tungsten boride phase that freed the pinned grain boundaries and the coalescence of two adjacent primary grains to form a large secondary grain. Grain-boundary migration rates were calculated for the primary and secondary grains in all the alloys. Small amounts of boron, of the order of 0.01 atomic percent were observed to decrease the grain-boundary migration rate of tungsten by three orders of magnitude. This decrease was attributed to the segregation of boron to the grain boundaries. Larger additions of boron (greater than 0.25 atomic percent) promoted the formation of tungsten boride, which pinned the boundaries at 3600 and 3800°F. At 4000 and 4200°F, the boride partially dissolved resulting in the release of the boundaries and a subsequent increase in the grain-boundary migration rate. (auth)

16077 (NYO-2394-12) A STUDY OF THE MECHANICAL PROPERTIES OF HIGH-COBALT CEMENTED TUNGSTEN CARBIDES. K. N. Tu and J. Gurland (Brown Univ., Providence, R. I. Div. of Engineering). Jan. 1965. Contract AT(30-1)-2394. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The mechanical properties of cemented tungsten carbide-cobalt alloys were investigated in the composition range of 50 to 70 volume per cent of cobalt. It was found that the fracture strength and hardness increase with decreasing particle size of WC and that the data are not in disagreement with the concept that particle diameter is the governing variable over most of the range. (auth)

16078 (ORNL-TM-1017) TENSILE AND CREEP PROPERTIES OF INOR-8 FOR THE MOLTEN-SALT REACTOR EXPERIMENT. J. T. Venard (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Tensile and creep-rupture testing has been carried out on three heats of INOR-8 selected from those used for the Molten-Salt Reactor Experiment (MSRE) construction. The data reported are ultimate tensile strength, 0.2% offset yield strength, percent elongation, and percent reduction in area vs temperature from room temperature to 982°C. Creep-rupture behavior was investigated at 593, 704, and 816°C. In general, the commercial MSRE construction material shows greater strength and ductility than did earlier heats of the alloy. Additional confidence in the MSRE design strength values is thus in order. (auth)

16079 (TID-21647) SIMPLE RELATIONSHIP BETWEEN ELECTRICAL CONDUCTIVITY OF LIQUID METALS AND TEMPERATURE, OVER THEIR ENTIRE LIQUID TEMPERATURE RANGE, i.e., FROM THE MELTING POINT TO THE CRITICAL POINT. Aristid V. Grosse (Temple Univ., Philadelphia, Pa. Research Inst.). Nov. 22, 1964. Contract AT(30-1)-2082. 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A simple empirical relationship was found between temperature and electric conductivity of the liquid metals Hg, K, Na, Rb, and Cs. The temperature and conductivity are expressed in terms of reduced quantities using the melting-critical temperature range, i.e., reduced temperature = 0 and 1 and reduced conductivity = 1 and 0 at melting point and critical point, respectively. Plots of reduced temperature vs reduced conductivity have the form of equilateral hyperbolas, hyperbola equations are given. The free-electron theory of the conductivity is discussed. (D.L.C.)

16080 (UCRL-7767) STRESS-CRACKING IN THE URANIUM–10 w/o MOLYBDENUM ALLOY. C. A. W. Peterson and R. R. Vandervoort (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 13, 1964. Contract W-7405-eng-48. 14p. (CONF-640404-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint Working Group Weapons Research Development Meeting, Aldermaston, Reading, Berks, Eng.

It was found that the U–10 wt % Mo alloy is subject to delayed failure in air. Oxygen was determined to be the embrittling agent. The critical stress, or threshold stress, for delayed failure is as low as 37,000 psi. This threshold stress increases with decreasing carbon content. The 0.2% offset yield strength of this alloy, in the dynamic tensile test, is typically 125,000 psi. (auth)

16081 (UCRL-11563) ELEVATED TEMPERATURE STRAIN AGING OF CONVENTIONAL AND AUSFORM STEELS (thesis). Virendra Singh Goel (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 75p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The strain-aging behavior of conventional H-11 and ausform H-11 steel was investigated by variation of prestrain temperature, prestrain rate and post-tempering temperature. The temperature during prestrain was varied from

300 to 900°F, the strain rate was varied from 1.35×10^{-5} to 1.35×10^{-3} sec^{-1}, and the post-tempering temperature was varied from 300 to 900°F. An increase in yield stress from 240,000 to 310,000 psi (a gain of 70,000 psi) was observed for conventional H-11 steel. Yield stress for ausform H-11 steel increased from 275,000 psi to 400,000 psi (a gain of 125,000 psi). There was no significant loss in ductility, and the ultimate tensile stress was slightly increased in both conventional and ausform steels. (auth)

16082 (UCRL-11752) THE ELECTRICAL TRANSPORT AND MECHANICAL PROPERTIES OF TANTALUM–MOLYBDENUM ALLOY SINGLE CRYSTALS (thesis). Lenon I. Van Torne (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 131p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The purpose of this investigation is to determine the reasons and mechanisms for the occurrence of cleavage and to increase the knowledge of electrical transport in transition metal alloys. The binary alloy series Ta–Mo was selected as being representative of the alloys which show cleavage. Single crystals of the Ta–Mo series were grown at about 10 atomic percent increments by electron beam zone refining. The methods of investigation of the prepared crystals included: specific resistivity at 273, 77, and 4.2°K, critical resolved shear stress for plastic flow or cleavage at 273°K, lattice parameter determination, transmission electron microscopy, and quantitative x-ray diffracted intensity measurements of {200} and {220} planes on spherical alloy single crystals. This investigation revealed that the alloys in the composition range of Mo–19 Ta to Mo–58 Ta cleave on the {100} planes. The lattice parameter measurements and transmission electron microscopy revealed that the alloy series is bcc with no long range or short range order of a dimension greater than 300 Å or intermediate phases. X-ray diffracted intensity measurements from {200} and {220} indicate that there exists a deviation from random solid solution in the crystals. The ratio of constituent atoms on {100} and {110} differ from the ratio of atoms corresponding to the total composition of the crystal in such a way as to generate quasi-cubic domains for {100} and quasi-dodecehedral for {110} deviations. However, even though there is a deviation from random solid solution composition on particular crystallographic planes, no periodic arrangement of atoms on these planes is evident. The increase in critical resolved shear stress for plastic flow with alloy composition results from a corresponding increase in the Peierls-Nabarro friction of dislocations produced by alloying, composition deviations on {100} or {110} and concomitant changes in the elastic coefficients. Cleavage occurs due to a violation of the strain energy restrictions on the elastic coefficients in a local region of the crystal. Alloying and the existence of composition deviations change the elastic coefficients, in the range of alloys which cleave, to values which marginally fulfill the strain energy restrictions. The presence of a critical density of dislocations in a local region produces changes in the values of the elastic coefficients such that the crystal is locally energetically unstable. The crystal then cleaves on a {100} plane which relieves the maximum strain energy. Marked changes in the slope of ($\rho_{273°K}$ minus $\rho_{4.2°K}$) versus alloy composition at Mo–20 Ta, Mo–50 Ta, and Ta–12 Mo reveal that there is a relatively large change occurring in the density of states in the d and s bands and/or marked changes in the elastic coefficients at these alloy compositions. (auth)

16083 (NP-tr-1221) ELECTROLYTIC PRODUCTION OF URANIUM AND THORIUM FROM FUSED SALTS. W. Rafalski. Translated by J. Adam (United Kingdom Atomic Energy Authority, Research Group, Harwell, Berks, Eng.), from a Paper Presented at the 2nd Yugoslav-Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, September 3-9, 1963. 31p. Dep.(mn); $3.60(fs), $1.13(mf) JCL.

A study has been made of production of massive uranium metal on a laboratory scale from uranium oxide using fused-salt electrolysis at 1200°C. Experimental data are included for the production of solid thorium–zinc alloys by simultaneous electrolytic deposition of Zn and Th in a fused fluoride bath at 1100°C. The cathode current density was approximately 6 amp/cm^2. (auth)

16084 (ORNL-tr-481) DEPOSITION AND PROPERTIES OF A PYROLYTIC CARBON OF LOW ORIENTATION. J. Rappeneau, M. Yvars, M. Bocquet, C. David, and A. Auriol. Translated for Oak Ridge National Lab., Tenn., from Carbon, 2: 149-61(1964). 26p. Dep.(mn); $2.60(fs), $0.98(mf) JCL.

Pyrolytic carbon obtained by thermal decomposition of acetylene at partial pressures of 0.02 to 0.1 atm, on walls heated to between 1550 and 1650°C, is characterized by a low density (1.35) and a not very marked perferential orientation of the crystallites. This latter property is expressed by an absence of laminar structure in the deposit and by its good compatibility with an artificial graphite substrate. Following a description of the method of deposition and an outline of the structural properties, certain physical and chemical properties of this substance are examined. (auth)

16085 (UCRL-Trans-1173(L)) DETERMINATION OF STATE DATA FOR URANIUM AT HIGH PRESSURES BY MEANS OF SHOCK WAVE EXPERIMENTS. P. A. Persson and I. Persson (Försvarets Forskningsanstalt, Stockholm (Sweden)). Translated by A. Senning (Univ. of California, Lawrence Radiation Lab., Livermore), from FOA 2 Report A 2299-222. Sept. 1964. 76p. Dep.(mn); $7.60(fs), $2.48(mf).

A series of shock-wave experiments was performed, in which the density of shock-wave compressed uranium was measured in the pressure region from 0.3 to 1.7 Mbar. An account is given of the experimental technique, calibration experiments, and the experimental results. The results show reasonable agreement with published data from both static and shock-wave experiments. (auth)

16086 A $D8_8$-TYPE PHASE IN THE YTTRIUM–TIN SYSTEM. Sven Holmen (Univ. of Stockholm). Acta Chem. Scand., 18: 2394(1964).

Mixtures of yttrium and tin were melted under helium in an electric arc furnace. The samples were then annealed 50 days at 850°C in evacuated and sealed silica tubes. The capsules were quenched in cold water. The samples of compositions around $YSn_{0.6}$ gave x-ray-diffraction patterns that could be indexed assuming a hexagonal unit cell with the dimensions a = 8.902 and c = 6.536 Å. These parameters were comparable with those of several $D8_8$-type compounds. Intensities calculated with atomic parameters of Y_5Sn_8 were found to be in good agreement with the observed data. (M.C.G.)

16087 STUDIES OF SOLUTION IDEALITY IN THE PRASEODYMIUM–NEODYMIUM SYSTEM. C. E. Lundin, A. S. Yamamoto, and J. F. Nachman (Univ. of Denver). Acta Met., 13: 149-54(Mar. 1965).

Solutions of the praseodymium–neodymium alloy system were studied both in the liquid and solid state. The thermodynamic activities at 1525, 1500, and 1475°C and densities at 1240°C were determined for the liquid alloy solutions, and the lattice parameters and densities were obtained for the room-temperature solid solutions. The resulting activities and atomic volumes were plotted against alloy composition in mole fraction, and, within experimental error, they exhibited a linear relationship. Therefore, it was concluded that praseodymium–neodymium alloy solutions behave essentially as ideal solutions both in the liquid and solid states. (auth)

16088 RELEASE PROCESSES IN METAL AND OXIDE TARGETS FOLLOWING BOMBARDMENTS WITH Xe AT ENERGIES UP TO 40 kev. Roger Kelly and F. Brown (Euratom, Ispra, Italy). Acta Met., 13: 169-80(Mar. 1965).

Radioactive Xe was injected into Al, Al_2O_3, Ta, Ta_2O_5, Ag, and Au at energies up to 40 kev, and the targets then heated in a vacuum to determine the release behavior. On

the basis of diffusion calculations, in which release temperatures were correlated with ΔH's and range parameters, it was found that the components of release are generally of three types, though there may be occasional effects due to phase changes. Release compatible with conventional diffusion data, i.e. "normal diffusion," was found under conditions of high bombardment energies, low gas concentrations, and (in some cases) annealing. A process, the temperatures for which lay between the bombardment temperature and that for "normal diffusion," were prominent whenever the energy was below 1 to 4 kev, the value depending on the target. This process was possibly the result of either bombardment damage (hence the name "damage diffusion") or the proximity of the surface. Release characterized by high temperatures correlated with high gas concentrations. There was good evidence that it was associated with the formation and motion of bubbles (hence the name "bubble diffusion"). Effects due to phase changes were observed in the particular cases of Al (melting) and Ta (oxide dissolution). Processes resembling those observed can also be recognized in a variety of published results. Included are studies on bombarded targets under conditions of average cleanliness, on bombarded oxide-free W under conditions of ultrahigh vacuum, on surfaces used for ion pumping, and on materials containing fission Xe. (auth)

16089 THE FRICTION STRESS AND INITIAL MICROYIELDING OF BERYLLIUM. W. Bonfield and C. H. Li (Honeywell Research Center, Hopkins, Minn.). Acta Met., 13: 317-23(Mar. 1965).

The friction stress of polycrystalline beryllium was studied as a function of dislocation substructure, with variations in dislocation density and distribution produced by controlled prestraining and thermal treatments. It was found that the friction stress of beryllium in the annealed condition increased considerably with small prestrains and then remained approximately constant with further prestrains. In contrast, the friction stress of hot-pressed beryllium, which had an identical grain size, but a different dislocation substructure to the annealed material, was virtually independent of all levels of prestrain. An analysis of these results indicated that the friction stress contains a significant contribution from dislocation configurations, which is discussed in terms of the nature of the operative deformation mechanisms in the microstrain region. The effects of similar variations of dislocation arrangement on the microscopic yield stress (the stress to produce a plastic strain of 2×10^{-6} in./in.) were contrasted with the effects on friction stress. A comparison was made of the results obtained on beryllium with equivalent studies on other metals. (auth)

16090 DIFFUSION OF Nb^{95} INTO TANTALUM SINGLE CRYSTALS. R. E. Pawel and T. S. Lundy (Oak Ridge National Lab., Tenn.). Acta Met., 13: 345-51(Mar. 1965). (ORNL-P-101)

Penetration curves were obtained for the diffusion of ^{95}Nb into tantalum single crystals at temperatures from 1050 to 1600°C. For conditions of the experiments, the curves were characterized by a region of large slope near the surface, followed by a region of much lesser slope deeper into the metal. Originally, the near-surface behavior in this case was thought to be anomalous in origin, occurring as a result of phenomena associated with extremely small penetration distances. However, the results indicated that this is probably not the case, that the first region is a result of lattice diffusion while the second portion is a consequence of the presence of short-circuit diffusion paths. Some of the complications of uniting the experimental procedures and results with the proper mathematical analysis for studies of near-surface diffusion are also discussed. (auth)

16091 A PRELIMINARY STUDY OF THE THERMOELECTRIC PROPERTIES OF THORIUM ARSENIDE, Th_3As_4. I. H. Warren and C. E. Price (Univ. of British Columbia, Vancouver). Advan. Energy Conversion, 4: 169-78(Dec. 1964).

Compacts of thorium arsenide, Th_3As_4, and its solid solutions with iron, cobalt, nickel, calcium and barium sulfides, uranium arsenide, and thorium antimonide were prepared by hot pressing. A thorium arsenide-antimonide solid solution is shown to have thermoelectric properties at 700°C that suggest this system should be studied further as a potential n-type thermoelectric generator material. (auth)

16092 TESTS ON THE EFFECT OF URANIUM IN GRAY CAST IRON. I. C. H. Hughes. BCIRA (Brit. Cast Iron Res. Assoc.) J., 12: 581-3(Sept. 1964).

Uranium is a chill inducing element in gray Fe, with a recovery of about 50%. At the 0.27% level, uranium is a mild carbide stabilizer and may improve tensile strength. At around 1% it produces a damaging mesh-like graphite structure with greatly reduced tensile strength and hardness. (Rev. Metal. Lit., 21: Dec. 1964).

16093 PLASTICS IN NUCLEAR ESTABLISHMENTS. H. Wells (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. Eng., No. 183, CE271-6(Nov. 1964).

Basic properties of plastics relevant to their use in nuclear establishments are discussed. These include: their resistance to contamination by radioactive substances, their resistance to nuclear radiation, and their neutron absorption or attenuation capacities. Some indication is given of how some of the more common plastics behave when exposed to these environments and some examples of the use of plastics in nuclear establishments are described. (auth)

16094 KINETICS AND DIFFUSION MECHANISM OF OXYGEN IN ALPHA-ZIRCONIUM AT DIFFERENT TEMPERATURES. Gerard Beranger (Ecole des Mines, Paris). Compt. Rend., 259: 4663-6(Dec. 21, 1964). (In French)

It was shown, by a gravimetric method, that the diffusion kinetics of oxygen in α-zirconium sub-jacent to the oxide layer responds to a parabolic law. The process of this diffusion seemed to be different at high and low temperatures. This suggested the possibility of an intergranular diffusion of the oxygen at temperatures less than 650°C, approximately. (tr-auth)

16095 NEW PROPERTIES OF ZIRCONIUM PURIFIED BY ZONE FUSION UNDER STATIC ULTRA-VACUUM. Marc Billion and Jean-Paul Langeron (CNRS, Vitry-sur-Seine, France). Compt. Rend., 259: 4671-4(Dec. 21, 1964). (In French)

After six passes of the fused zone, the recrystallization temperature of Zr was lowered to 160 to 165°C and the ratio of electric resistivities ($R_{20.4}/R_{299.6°k}$) to 38×10^{-4}. The metal thus purified made it possible to follow, after rolling, the effect of the anneal temperature on the hardness and grain size and the variation of these two properties along the rod after purification. (tr-auth)

16096 INFLUENCE OF TEMPERATURES OF INTERMEDIATE AND FINAL ANNEALINGS ON THE DUCTILE-BRITTLE TRANSITION ZONE OF α URANIUM. Jean Morin and Francois Jean-Louis (Ecole des Mines, Paris). (Compt. Rend., 260: 541-4(Jan. 11, 1965). (In French)

The effect of thermal treatments of samples, annealed in the α phase, on the plastic behavior of polycrystalline uranium was studied by traction tests. It was established that the intermediate anneal temperature, while permitting the complete recrystallization of the metal, should be as low as possible in order to give the metal a high ductility. (tr-auth)

16097 EFFECT OF PLASTIC DEFORMATION ON THE FINE STRUCTURE OF MOLYBDENUM SINGLE CRYSTALS. E. M. Savitskii and N. N. Bokareva. Dokl. Akad. Nauk SSSR, 159: 1137-9(Dec. 11, 1964). (In Russian)

Molybdenum single crystals, 99.77%-pure, obtained by electron-beam zone refining from twice vacuum-arc-melted molybdenum, were cold rolled with a 2% max reduction per pass. The single crystals were highly ductile and at room temperature sustained a total reduction of

more than 90% without failure. A study of deformation-induced changes in the single-crystal substructure revealed fragmentation and disorientation of the blocks whose boundaries were in the active slip planes. With increasing degree of deformation, the blocks turn in the direction of the force and the disorientation increases. A fibrous structure begins to form with a deformation greater than 80%. No hardness anisotropy was observed in as-cast single crystals. The microhardness along the (100), (110), and (111) planes was 156–157 kg/mm^2. The density of the etch pits was on the order of 10^3/cm^2 in both the (100) and (111) planes. (ATD)

16098 NEW COMPOUND IN THE SYSTEM CERIUM–ALUMINIUM. P. I. Krypyakevich and I. I. Zalutskii (Lvov Ivan Franko State Univ., Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 1, 54-6(1965). (In Ukrainian)

A compound $CeAl_3$ was found by means of x-ray diffraction analysis. It has the structure of the Ni_3Sn type [x = 0.860 ± 0.005; a = 6.541 ± 0.005, c = 4.610 ± 0.003 Å, c/a = 0.705] and exists in equilibrium with $CeAl_2$ and $CeAl_4$. (auth)

16099 SOME PHYSICAL PROPERTIES OF LANTHANUM DIGERMANIDE. Y. B. Paderno, A. B. Goncharuk, and V. N. Makarchenko. Dopovidi Akad. Nauk Ukr. RSR, No. 1, 56-8(1965). (In Ukrainian)

An investigation was made of the physical properties of lanthanum digermanide on samples obtained by sintering the components and subsequent smelting in an argon atmosphere. On the basis of the results obtained it was concluded that lanthanum digermanide possesses semiconductor properties. (auth)

16100 A CHEMICAL STRIPPING OF DIRECT CARBON REPLICAS ON ThO_2. A. Bassi and G. Camona (CISE, Milan). Energia Nucl. (Milan), 12: 104(Feb. 1965).

A stripping bath of fluoboric and phosphoric acid at about 110°C was used in observation of ThO_2 surfaces by means of direct carbon replicas. The required time was 5 min. For observation of polished surfaces or for morphological examination of etched surfaces, stripping was performed with boiling phosphoric acid. The required time was 15 to 20 min. (D.C.W.)

16101 STUDIES OF THE RECOVERY OF AN INTERNAL FRICTION PEAK IN COLD-WORKED TUNGSTEN. Bernard R. Martinet (Universite, Lausanne, Switzerland). Helv. Phys. Acta, 37: 673-88(1964). (In French)

Determination, using a torsion pendulum, of the migration of point defects at stages III and IV in cold-worked tungsten is discussed. The classical inverted torsion pendulum was improved and consists of 4 inertial discs. In this way it is possible to measure the internal friction at 4 different frequencies and to determine the relaxation energy E_R of the process responsible for the peak. The internal friction peak of the cold-worked tungsten recovered in the neighborhood of the temperature at which it was measured. Different specimens were subjected either to isochronal annealing or isothermal annealing in order to determine the different stages of recovery and the migration energy, E_m. Measurements of the peak for four different periods allowed the relaxation energies E_R, E'_R of the peak, and the exponential climb to be determined. The results followed the equation in which α represents the coefficient of expansion of the peak with respect to a process with only one relaxation time. These results allow the most probable physical interpretation to be found. The internal friction peak was assumed to be due to the interaction between dislocations and vacancies. At stage III A, the interstitial atoms migrated towards the dislocations and recombined with the existing vacancies there. At stage III B, the interstitial atoms trapped by impurities became free and migrated in their turn towards the dislocations. At stage III C, the vacancies migrated along the dislocations and accumulated there, forming heaps. At stage IV the heaps of vacancies also migrated along the dislocations and collected all remaining vacancies. (auth)

16102 GRAPHITE AS GRAIN GROWTH INHIBITOR IN HOT-PRESSED BERYLLIUM OXIDE. Kasimir Langrod (Atomics International Inc., Canoga Park, Calif.). J. Am. Ceram. Soc., 48: 110-11(Feb. 21, 1965).

Additions of graphite or carbon black were effective in inhibiting grain growth in hot-pressed BeO. A 1% addition of graphite, added with a high-shear blender, was found to be most effective. (M.C.G.)

16103 GROWTH AND CHARACTERIZATION OF URANIUM-DOPED GERMANIUM SINGLE CRYSTALS. H. R. Killias, S. N. Dermatis, and H. C. Gatos (Massachusetts Inst. of Tech., Cambridge). J. Electrochem. Soc., 112: 362-3(Mar. 1965).

Uranium-doped germanium single crystals were grown from the melt by the Czochralski method using a graphite crucible and pre-purified nitrogen as the furnace atmosphere. The mica detector method was used to study the distribution of uranium in grown crystals. Electric conductivity and Hall effect for some of the crystals were measured between 80 and 400°K. (M.C.G.)

16104 THE SURFACE TENSION OF LIQUID URANIUM FROM ITS MELTING POINT, 1406°K TO 1850°K. J. A. Cahill and A. D. Kirshenbaum (Temple Univ., Philadelphia). J. Inorg. Nucl. Chem., 27: 73-6(Jan. 1965).

The surface tension of liquid uranium was measured from its melting point (1406°K) to 1850°K by the maximum bubble pressure method with a probable error of 40 dyn/cm, or 2.5% at the melting point. Impervious aluminium oxide tubes having a tip measuring 2 mm OD × 0.3 mm wall × 5 mm long were immersed in the liquid uranium, which was held in a thorium dioxide crucible contained in a molybdenum tube under argon. Extrapolation of the data to the melting point (1406°K) gave a preliminary value of 1550 dyn/cm. From the experimental points and the relationship $\Delta\sigma/\Delta T = \sigma_{m.p.}(T_c - T_{m.p.})^{-1}$, the following tentative equations for the surface tension of liquid uranium were determined: σdyn/cm = 1747 − 0.14T(°K) or σdyn/cm = 1550 − 0.14(T − 1406°K). (auth)

16105 THE PRECIPITATION OF INTERMETALLIC COMPOUNDS IN ADJUSTED URANIUM. P. L. Ryder and J. Nutting (Univ. of Leeds, Eng.). J. Inst. Metals, 93: 178-81(Feb. 1965).

Thin-foil transmission electron-metallographic techniques were used to study the morphology of the precipitates present in adjusted uranium after quenching and furnace-cooling from the γ region, followed by aging in both the β and α regions. UAl_2 formed at β boundaries, while an unidentified precipitate having a lattice parameter of 7.33 ± 0.04 Å formed in the α phase. A mechanism of precipitation on dislocation loops is suggested to explain the production of long lines of fine precipitates in adjusted uranium that is furnace-cooled from the γ phase. (auth)

16106 THE BRITTLENESS OF EXTRUDED BERYLLIUM TUBES. G. B. Greenough (United Kingdom Atomic Energy Authority, Salwick, Lancs, Eng.). J. Inst. Metals, 93: 199(Feb. 1965).

Beryllium tubes of adequate ductility were prepared by rifle-drilling from hot-pressed and sintered (but not extruded) beryllium blocks. Fuel elements from these materials successfully withstood 98 thermal cycles between 700 and 25°C, where the can was pressed down on the UO_2 fuel at 700°C between each cycle. (M.C.G.)

16107 POLYGONIZATION OF VERY PURE URANIUM BETWEEN 150 AND 300°C. G. Clottes, J. C. Jousset, and J. Leteurtre (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater., 12: 340-4(1964). (In French)

The energy of activation of the polygonization of very pure uranium was determined as a function of temperature. The mechanism was studied. The results showed that in very pure uranium two phenomena are produced between 150 and 300°C. The first is the rapid augmentation, with temperature, of the coherence of the majority of macles. The second is the formation of dislocation lattices, which are more and more regular with increasing temperature for the thermal treatment. (J.S.R.)

16108 SPECIFIC SURFACE AREA OF SWAGED UO_2 COMPACT. Tadashi Kubota, Yutaka Honda, and Shuichiro Takahashi (Mistubishi Atomic Power Industries Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 2: 1-6(Jan. 1965).

The specific surface area was measured on swaged UO_2 compacts by the BET method using Kr as an adsorbate. The procedure for specimen preparation of swaged UO_2 compact is discussed. Measured values of cold swaged UO_2 compact (88% theoretical density) were mostly 0.51 to 0.70 m^2/g, while those of hot swaged UO_2 compact (94% theoretical density) were mostly 0.05 to 0.13 m^2/g. (auth)

16109 INVESTIGATION OF WORKABILITY OF TANTALUM AND COLUMBIUM BY PRESSURE. B. N. Shevelkin and L. L. Kravchenko. Khim. i Neft. Mashinostr., No. 1, 25-7(1964). (In Russian)

Ta and Nb sheets, 1 mm in thickness, were tensile tested, cold drawn, argon arc welded, and flanged in non-annealed and vacuum annealed states. Determination was made of maximum admissible deformation degrees during shaping and optimum vacuum annealing conditions for maximum ductility at room temperature. Anisotropy of mechanical properties and corrosion resistance of shapings in various corrosive mediums is discussed. (Rev. Metal. Lit., 21: Dec. 1964).

16110 SUPERCONDUCTING WIRE AND TAPE. R. J. Slaughter and I. K. Kang. Metal Ind. (London), 105: 269-72(Aug. 27, 1964).

Types of superconducting materials (solid solutions such as Nb–Zr, Mo–Re, Nb–Ti, Pb–Bi, Nb–V, and the intermetallic compounds such as Nb_3Sn, Nb_3Ga, V_3Si), their fabrication, methods employed to prevent atmospheric contamination during manufacture, application in high magnetic field solenoids, in 50 c/s power transformers and as a magnetic screen to control the shape of a magnetic field, and testing by short specimen performance are discussed. (Rev. Metal. Lit., 21: Dec. 1964)

16111 HIGHLY WORKABLE NEW ALLOY OF BERYLLIUM + ALUMINUM. Mod. Metals, 20: No. 8, 72-3(Sept. 1964).

In alloy containing 62% Be and 38% Al has high elastic modulus, low density, good formability, ductility, machinability, weldability, and mechanical fastening at temperatures from 600 to 800°F. Uses include missiles, satellite launch vehicles supersonic aircraft, gyrocages, computer memory drums, nuclear fuel canning and radiator sections in space vehicles. (Rev. Metal. Lit., 21: Dec. 1964)

16112 SURFACE GAS ERUPTION AND VAN DER WAALS COHESION ON TUNGSTEN. L. Jacob (Univ. of Strathclyde, Glasgow). Nature, 205: 584(Feb. 6, 1965).

A method for determining the Van der Waals cohesion of the topmost atoms in a multilayer gas film on W is described. The effect of the field, E, is to polarize the adsorbed gas layer and put a strain on the film; the force on a single atom $\alpha EdE/dz$ where α is its polarizability works out at $\sim 1/10^{12}$ newtons. This tensile force acts in the presence of a random positive ion bombardment of the point by molecular and atomic ions of oxygen, nitrogen, carbon monoxide, and carbon at a rate of about 500/sec; the recovery time of the surface may have values up to and beyond 1 msec. A value for the cohesive energy of the gas can be derived by considering the momentum of the impacting particle to be shared between the gas and the tungsten/oxide substrate, according to their binding energies B_g and 10 ev, respectively. (P.C.H.)

16113 IDENTIFICATION OF A BETA–TUNGSTEN PHASE IN TUNGSTEN–RHENIUM ALLOYS. J. I. Federer and R. M. Steele (Oak Ridge National Lab., Tenn.). Nature, 205: 587-8(Feb. 6, 1965). (ORNL-P-884)

Alloys containing 13-45 wt % Rh prepared by vapor deposition at 500°C were found to contain a phase having a β-tungsten type structure not previously reported in W–Rh alloys. No evidence for the presence of sigma phase or elemental Rh was found. The lattice parameter of the β-tungsten structure was found to be $a_0 = 5.0182 \pm 0.005$ A with 22 wt % Rh. Data on other properties of the β-phase are tabulated. (P.C.H.)

16114 FISSION-GAS RELEASE FROM NUCLEAR FUELS. I. DIFFUSION OF ^{133}Xe IN SINTERED URANIUM CARBIDES. Yasutaka Osawa and Kazuaki Takezawa (Mitsubishi Atomic Power Industry, Inc., Omiya Saitama Prefecture, Japan). Nippon Genshiryoku Gakkaishi, 7: 7-14 (Jan. 1965). (In Japanese)

The diffusion parameters of ^{133}Xe in irradiated sintered pellets of several different uranium carbides were measured in post-irradiation annealing experiments in the temperature range of 1,000 to 1,400°C. A rapid increase of ^{133}Xe release was observed when the pellets reached 200 to 600°C while being heated to 1,000°C. It was considered that this rapid release of ^{133}Xe could be explained, not by the diffusion model, but by the desorption phenomenon of ^{133}Xe evolved and adsorbed on the pellet surface during irradiation. The apparent diffusion coefficient (D′) obtained here appeared to depend mainly on the actual surface area of the pellet and not on the fraction of its theoretical density. The values of D′ obtained for carbides at 1,400°C were of the same order of magnitude as the values reported for sintered 97% dense UO_2 pellets. The diffusion coefficients of all samples were found to be in the range of 1×10^{-19} to $1 \times 10^{-16} cm^2/sec$ at 1,000°C and 1×10^{-16} to $2 \times 10^{-15} cm^2/sec$ at 1,400°C, with activation energies of 50 to 78 kcal/mol. (auth)

16115 ON THE CRYSTAL STRUCTURE AND THERMAL EXPANSION IN THE WELDED ZONE OF ZIRCONIUM. Gunji Shinoda (Osaka Univ.) and Yoshitsugu Amano. Nippon Kinzoku Gakkaishi, 28: 644-8(1964). (In Japanese)

The crystal structure and nature of thermal expansion in the welded zone of zirconium were studied by x-ray methods in the temperature range of 25 to 300°C. The preferred orientation was found in the welded zone. The axial ratio (c/a) in the welded zone was larger than that obtained after recrystallization of the same zone. The linear thermal expansion coefficient in a-axis direction in the welded zone increased with increasing temperature in the same way as it and the linear thermal expansion coefficient in the c-axis direction increased in the non-welded zone, but the linear thermal expansion coefficient in the c-axis direction in the welded zone was nearly independent of temperature. From these results, it can be predicted that oxygen or nitrogen atoms dissolved in the zirconium matrix during the welding play some role in the increase of the lattice constant parallel to the hexagonal axis and that they may migrate from an unstable site to a stable site with rise of temperature. (auth)

16116 ON THE RECOVERY OF LATTICE STRAIN IN WELDED ZIRCONIUM. Gunji Shinoda (Osaka Univ.) and Yoshitsugu Amano. Nippon Kinzoku Gakkaishi, 28: 648-53 (1964). (In Japanese)

The recovery of lattice strain in welded zirconium, 50% cold rolled, was studied on the basis of the change of half breadth of x-ray diffraction lines. The recovery of lattice strain of the c-axis direction in the welded and non-welded zones showed nearly the same rate in the isothermal recovery curve, particularly, at a high temperature. However, the recovery of the a-axis direction in the welded zone was retarded as compared to that in the non-welded zone. Recrystallized grains in the welded zone did not appear even on annealing at 800°C for 1 hr, whereas in quenched zirconium showing a similar structure to the welded zone they were found on annealing at 600°C for 1 hr. From these results it was concluded that inhomogeneously dissolved oxygen and other gases during the welding play an important role in the recovery process as well as in the thermal expansion. (auth)

16117 ABSOLUTE INTENSITIES OF X-RAYS ANOMALOUSLY DIFFRACTED THROUGH NEARLY PERFECT COPPER CRYSTALS. R. M. Nicklow, F. A. Sherrill, and F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A1417-22(Mar. 1, 1965). (ORNL-P-604)

Absolute integrated intensities of the x-ray beams "anomalously transmitted" through nearly perfect copper crystals were measured for the (111) planes for values of μt ranging from 10 to 90. Results obtained for both the symmetric and

asymmetric Laue geometries are compared with theory. These comparisons yield a value of 0.965 ± 0.003 for the ratio f''(111)/f''(000) and indicate that the crystals investigated have a high degree of perfection. The measurements were made with MoKα radiation using a double-crystal spectrometer arranged in the parallel condition and with the first crystal diffracting in the Bragg geometry. Measured profiles of the Bragg-Laue double-crystal rocking curves for μt = 10 and 90 are in semi-quantitative agreement with the theory. (auth)

16118 HALL EFFECT IN PLUTONIUM. Merwyn B. Brodsky (Argonne National Lab., Ill.). Phys. Rev., 137: A1423-8(Mar. 1, 1965).

The Hall effect was measured on pure alpha and beta Pu and on a 3.4 at. % Al-stabilized delta-phase alloy. Measurements were made between 6 and 438°K with magnetic fields up to 21 kgauss. In each phase, the Hall coefficient R_0 is positive and relatively independent of temperature at higher temperatures, but shows strong temperature dependence at low temperatures. R_0 for alpha Pu becomes negative at 185°K and goes through a minimum at 23°K. The R_0's for beta Pu exhibit a maximum at 29°K and then drop sharply to negative values below 17°K. The value remains positive, with no maximum, for the delta alloy throughout the temperature range. The data were used to test a two-band model and were found to fit best to a nearly full 7s band and empty 5f band. Because of similarities with data on the rare-earth metals, the low-temperature behavior of R_0 for each phase is thought to be due to antiferromagnetic ordering, but the anomalies in the electrical resistivity of the three phases are probably due to interband scattering. (auth)

16119 NUCLEAR-MAGNETIC-RESONANCE STUDY OF Sc_3In. B. J. Wyluda, R. G. Shulman, B. T. Matthias, and E. Corenzwit (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 137: A1856-7(Mar. 15, 1965).

Nuclear-magnetic-resonance measurements of the ^{45}Sc resonance in different Sc-In alloys as a function of composition and temperature are reported. Two resonances are observed, one of which is shifted to lower magnetic fields. The shift is proportional to the susceptibility. It is suggested that the shifted resonance is associated with the DO_{19} superlattice phase. (auth)

16120 DISPERSION CURVES AND LATTICE FREQUENCY DISTRIBUTION OF METALS. K. Krebs (EURATOM-CCR, Ispra, Italy). Phys. Rev., 138: A143-7 (Apr. 5, 1965).

A lattice-dynamical 3-constant model for metals is presented. The treatment takes complete account of the symmetry requirements of the lattice. The influence of conduction electrons is considered through the screening of the long-range Coulomb interaction between ions. The theory is used to calculate dispersion curves, frequency spectra, and lattice specific heats of Li, Na, and K. For sodium, good agreement is found with the dispersion curves obtained from measurements of the inelastic scattering of slow neutrons. (auth)

16121 OPTICAL AND ELECTRICAL STUDIES OF ELECTRON-BOMBARDED GaSb. R. Kaiser and H. Y. Fan (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: A156-61 (Apr. 5, 1965).

Studies were made on n- and p-type gallium antimonide irradiated with 4.5-Mev electrons. Hall-effect measurements showed that acceptors were produced in the n-type samples and that donors as well as acceptors were produced in the p-type samples. Infrared absorption and photoconductivity studies gave evidence for four defect levels: E_v + 0.075 ev, E_v + 0.48 ev, E_c – (0.12 to 0.20) ev, E_c – (0.47 to 0.50) ev. The absorption associated with the level E_v + 0.075 ev is similar to that observed in donor-compensated GaSb. Previous studies have indicated that such a level is present also in undoped p-type material. This work provides direct evidence that some of the residual impurities normally found in GaSb are lattice defects. Carrier capture cross sections were estimated for the various levels. The values indicate that the level E_c – (0.47 to 0.50) ev is an acceptor level, while the level E_c – (0.12 to 0.20) ev is probably a donor level. (auth)

16122 SYSTEMATICS OF HYPERFINE FIELDS IN AN IRON LATTICE. D. A. Shirley and G. A. Westenbarger (Univ. of California, Berkeley). Phys. Rev., 138: A170-6 (Apr. 5, 1965). (UCRL-11664; UCRL-11664(Rev.))

A survey is presented of the observed hyperfine fields at nuclei of impurities dissolved in metallic iron. Estimates are made from atomic hfs constants of the contributions to internal fields that might be expected on the basis of conduction-electron polarization. The observed fields in several heavy elements are roughly proportional to the fields attributed to the outer s electrons in the free atoms. The signs and magnitudes, and especially the Z dependence, of these fields are compatible with the conduction-electron polarization mechanism. Other internal fields, particularly for Cs and Ba in Fe, are predicted, to test this mechanism further. A tentative basis is thus established for estimating the hyperfine fields at impurities in iron. These estimates should be useful in planning Mössbauer or nuclear polarization experiments. (auth)

16123 MÖSSBAUER EFFECT IN THE ANTIFERROMAGNETIC $FeGe_2$ ALLOY. G. Fabri, E. Germagnoli, M. Musci, and V. Svelto (Laboratori Centro Informazioni Studi Esperienze, Milan). Phys. Rev., 138: A178-9(Apr. 5, 1965).

Nuclear-resonance transmission experiments were performed with the $FeGe_2$ alloy. Magnetic splitting is observed below 12°C, which supports previous conclusions that the alloy becomes antiferromagnetic somewhat below room temperature. Magnetic induction at the iron nuclei was measured as a function of temperature. (auth)

16124 OPTICAL PROPERTIES OF GRAPHITE. E. A. Taft and H. R. Philipp (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 138: A197-202(Apr. 5, 1965).

The complex dielectric constant $\epsilon(\omega) = \epsilon_1 + i\epsilon_2$ and associated functions are derived by application of the Kramers-Kronig relation to reflectance data for graphite obtained in the energy range to 26 ev. It is possible to divide the optical properties into two spectral regions. In the range 0 to 9 ev, intra- and interband transitions involve mainly the π bands. At higher energies, a broad absorption peak near 15 ev is associated with interband transitions involving the 3 σ electrons per atom. This viewpoint is strongly supported by evaluation of the sum rules for n_{eff}. Plasma resonances which produce peaks in the energy-loss function $-\mathrm{Im}\epsilon^{-1}$ at 7 and 25 ev are identified and described physically. At low energies, structure in the reflectance curve near 0.8 ev is attributed to the onset of transitions between the E_2 and E_3 bands at the point K. This yields a value for γ_1 of ≈0.4 ev. (auth)

16125 ANOMALOUS THERMAL EXPANSION AND MAGNETOSTRICTION OF SINGLE-CRYSTAL DYSPROSIUM. A. E. Clark, B. F. DeSavage, and R. Bozorth (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Phys. Rev., 138: A216-24(Apr. 5, 1965).

The temperature and field dependences of the magnetostriction and thermal expansion of single-crystal dysprosium metal were measured in the paramagnetic, spiral, and ferromagnetic regions. In the paramagnetic temperature range from the Néel point to room temperature, the thermal expansion is normal and the six lowest order magnetostriction coefficients vary as H^2. As the temperature is lowered and the spins align, the magnetostriction becomes immense (0.62% at 80°K) and terms in the thermal expansion attributed to thermal vibrations are dwarfed by those arising from the magnetoelastic energy (≈350 cm^{-1} $atom^{-1}$). Consequently, large discontinuities in the length of the hexagonal a and c axes occur when the spiral spin structure changes into the aligned configurations. Because the basal plane is the plane of easy magnetization in dysprosium, the basal-plane shearing magnetostriction is measurable over a wide range in temperature. Good agree-

ment for this coefficient is found between the measured magnetostriction and that predicted by the single-ion magnetoelastic coupling theory [$\lambda(T) = \lambda(0)\hat{I}_{\frac{1}{2}}$ ($\mathscr{F}^{-1}(m)$)]. The magnetostriction is proportional to m^3 at low temperatures and to $3m^2/5$ at high temperatures with the exceptionally large proportionality constant of $\lambda(0) = 8.5 \times 10^{-3}$. (auth)

16126 MÖSSBAUER EFFECT IN Dy^{161} IN METALLIC DYSPROSIUM, $DyFe_2$, AND $DyAl_2$. S. Ofer, M. Rakavy, E. Segal, and B. Khurgin (Hebrew Univ., Jerusalem). Phys. Rev., 138: A241-6(Apr. 5, 1965).

The recoilless absorption spectra of the 26-kev γ rays from ^{161m}Dy and ^{161}Dy situated in Dy metal, $DyFe_2$, and $DyAl_2$ were measured at various temperatures. A value of (−825 ± 30) Mc was found for the magnetic hyperfine constant ($g_I\mu_n H_{eff}$) of the ground state of ^{161}Dy in Dy metal at 20°K. This value is in very good agreement with the free-ion value calculated for the Dy^{3+} ions in the fully magnetized state ($J_z = J$) from data on electron spin resonance in dilute salts. The internal magnetic field acting on the Dy nucleus in $DyFe_2$ at magnetic saturation is (14 ± 2)% higher than in Dy metal. The magnetic field acting in $DyAl_2$ at magnetic saturation is the same, within the experimental errors, as in Dy metal. The ratio of the magnetic moments of the 26-kev level and the ground state of ^{161}Dy was found to be −1.19 ± 0.05. An isomeric shift of (2.5 ± 0.4) mm/sec was found between Dy metal and Dy_2O_3 absorbers. The isomeric shifts of $DyAl_2$ and $DyFe_2$ absorbers relative to a Dy_2O_3 absorber were found to be (0.4 ± 0.4) mm/sec. (auth)

16127 DISPERSION RELATIONS OF WHITE TIN. R. E. Schmunk and W. R. Gavin (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev. Letters, 14: 44-6(Jan. 11, 1965).

Preliminary results are presented for the dispersion relations of white tin, as determined by slow-neutron scattering. The results include the doubly degenerate transverse acoustical branch for the phonon wave vector in the (001) direction and one of the transverse acoustical branches for the (100) direction. (D.C.W.)

16128 PHONON DISPERSION IN METALS. Narendra Singh and S. K. Joshi (Univ. of Allahabad, India). Physica, 30: 2105-18(Dec. 1964).

A simple lattice dynamical model for metals is proposed. A b-c-c lattice of ion cores imbedded in a responding background of electron gas is considered. The total potential energy of the lattice is evaluated as sum of a Coulombic part due to the ion-ion, ion-electron and electron-electron interactions and a non-Coulombic short range part due to ion-ion exchange repulsion and Van der Waals attraction. A secular equation determining the frequencies of the normal modes of vibration is derived. The dispersion relations are presented for propagation vectors in the [100], [110], [111] directions. Comparison is made in the case of sodium with experimental data obtained from neutron spectrometry. Series termination errors in certain lattice sums entering in Coulomb coupling coefficients are considered. (auth)

16129 ANISOTROPIC K ABSORPTION OF UNPOLARIZED AND POLARIZED X RAYS IN A GALLIUM SINGLE CRYSTAL. W. M. Weber (Rijksuniversiteit, Groningen, Netherlands). Physica, 30: 2219-31(Dec. 1964).

The K-absorption spectrum of a thin Ga single crystal was recorded photographically for two directions of the incident x-ray beam, one being parallel with the c axis of the crystal, the other making an angle of 52° with the c axis. The investigation was made for an effective zero polarization, 37% linear polarization, and complete linear polarization of the x rays. In the latter cases different orientations of the polarization vector were taken. The Ga K fine structure was found to be most pronounced in all cases where the electric vector vibrated exclusively perpendicular to the c axis. A gradual reduction of the amplitudes of the extended fine structure could be obtained by increasing the angle between the x-ray beam and c axis; by increasing the angle between the polarization vector and the crystallographic ab plane, and by varying the degree of polarization of the beam. In no case did a measurable shift in the absorption fine-structure positions occur. The influence of the order in which absorbing foil and analyzing crystal are placed on the spectral intensity is discussed. This influence depends, in general, on the degree of polarization of the incident beam but is negligible in these experiments. The degree of polarization p_0 of the continuous radiation from the x-ray tube was measured between 1200 and 1160 XU for tube voltages of 13 and 20 kv; p_0 was found to be −24 ± 2% and −10 ± 1% respectively. A distinction is made between effective and final degree of polarization in x-ray absorption work. (auth)

16130 INVESTIGATION OF THE TERNARY SYSTEM CERIUM–THORIUM (URANIUM, ZIRCONIUM, MOLYBDENUM)–CARBON. P. Stecher, A. Neckel, F. Benesovsky, and H. Nowotny (Metallwerk Plansee, Reutte/Tyrol, Austria and Universität, Vienna). Planseeber. Pulvermet., 12: 181-95(Dec. 1964). (In German)

The systems discussed were investigated by x-ray methods using specimens prepared by means of powdered cerium hydride. By melting point measurements and metallographic investigations within the cerium-carbon binary system a preliminary phase diagram containing the phases Ce_2C_3 and CeC_2 was established. With respect to the ternary system Ce–U–C solid solutions (U,Ce)C up to 30 mole % "CeC" were found, while U_2C_3 and UC_2 had negligible solubility for cerium carbide only. The cerium carbides also dissolved small amounts of uranium carbides only. In the system Ce–Th–C, a series of solid solutions ThC-"CeC" up to about 40 mole % "CeC" were observed. The anomalous behavior of the cell volume was accounted for either by assuming a continuous change in the cerium radius caused by electron transfer or by carbon defect. ThC_2 incorporated considerable quantities of cerium–dicarbide (about 40 mole %); Ce_2C_3 and CeC_2 dissolved approximately 10 mole % of the corresponding thorium carbides. In the ternary systems Ce–Zr(Mo)–C only the binary phases were observed. (auth)

16131 INVESTIGATION OF CARBON DIFFUSION INTO TUNGSTEN AND MOLYBDENUM IN CASE OF LOW CARBON CONCENTRATIONS. L. N. Aleksandrov and V. Ya. Shchelkonogov. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 4, 28-32(1964). (In Russian)

Wires of 0.8 to 0.4 mm in diameter of W and Mo were coated by graphite lubricant film, which was inseminated by ^{14}C isotope, and annealed in H medium from 1100 to 1450°C. Tracing analysis of carbon diffusion into surfaces of W and Mo wires was undertaken to determine the possibility of C diffusion from the traces of graphite lubricant film that remain on the surfaces during die drawing of Mo and W wires. (Rev. Metal. Lit., 21: Dec. 1964)

16132 A MOLYBDENUM-OXIDE NEGATIVE-RESISTANCE DEVICE. C. Pettus (IBM Corp., Endicott, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 98(Jan. 1965).

Hysteresis was studied for samples (~400mm³) of mixed MoO_3 and MoO_2 (100 : 1 to 20 : 1) because of a negative I-V characteristic observed in other investigations. Possible explanations are outlined. (R.E.U.)

16133 THE FERMI SURFACE OF BERYLLIUM. B. R. Watts (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 282: 521-46(Dec. 8, 1964).

The Fermi surface of beryllium was determined experimentally by studying the de Haas-van Alphen effect of single crystals in pulsed magnetic fields. The de Haas-van Alphen frequency (proportional to the extremal area of the Fermi surface normal to the field) was measured as a function of field direction. Consideration of the hexagonal symmetry of the Brillouin zone shows that only six distinct classes of frequency variation with field direction are possible, and these considerations are used to deduce the locations and forms of the various sheets of the Fermi surface. The Fermi surface is found to consist of hole and electron surfaces of equal volume (each containing 0.162 carrier per atom). The hole surface is somewhat like a coronet, i.e., a ring of six smoothed tetrahedra joined by small necks lying in the central (0001) plane of the first double Brillouin

zone, and the electron surface is a set of six roughly ellipsoidal surfaces (cigars) lying on the vertical edges of the second double zone. Detailed shapes and sizes are deduced for the coronet and cigars such that the extreme areas of cross-section are consistent to within 1% of those obtained from the observed de Haas-van Alphen frequencies. No oscillations of frequency corresponding to the outer (0001) orbit round the coronet were, however, observed; a study of the field dependence of amplitude of the oscillations from the coupled orbit round the cigar shows that this absence can be explained by magnetic breakdown of the $\{10\bar{1}0\}$ band gap. The model described is in good agreement with the predictions of recent band structure calculations, and is consistent with other experimental evidence. (auth)

16134 DECANTATION OF THE OXIDES AND SULPHIDES PRODUCED IN THE TREATMENT OF MOLTEN IRON BY URANIUM. M. Olette and C. Gatelier, Rev. Met. (Paris), 61: 1117-18(Dec. 1964). (In French)

On the basis of a study on the treatment of molten steel with uranium it was found that the uranium oxide particles concentrate at the bottom end of the ingot. The sulfide particles, which generally were much smaller, remained uniformly distributed in the solidified metal. (auth)

16135 A STUDY OF THE SHIFT OF FRINGES IN MOIRE PATTERNS OF GRAPHITE. Jih-sheng Lee, Chi-fung Tien, and I-djen Ho. Sci. Sinica (Peking), 14: 310-15 (Feb. 1965).

An examination of the micrographs of graphite flakes gave further evidence that the line shifts in the moire patterns of graphite crystals result from the presence of basal dislocations. By analysis of the shifted regions, a total dislocation was distinguished from the partial dislocations; and the Burgers vectors of some of the extended dislocations were determined. (D.C.W.)

16136 SCREW DISLOCATIONS IN GRAPHITE. G. R. Henning (Argonne National Lab., Ill.). Science, 147: 733-4 (Feb. 12, 1965).

Graphite contains varying concentrations of screw dislocations whose Burgers vector parallels the c axis. Single crystals of natural graphite contain very few such dislocations; furthermore, their Burgers vector always exceeds 450 Å. Pyrolytic graphites annealed above 3000°C contain abundant screw dislocations, ranging from 10^6 to 5×10^8 per cm^2 in two different samples prepared by somewhat different methods. The Burgers vectors of these screws are predominantly 3.35 Å. (auth)

16137 CAN PRESSURE DESTROY SUPERCONDUCTIVITY IN ALUMINUM? M. Levy and J. L. Olsen (Swiss Federal Inst. of Tech., Zurich). Solid State Commun., 2: 137-9(May 1964).

It was found that the relation between T_c, the superconducting transition temperature, and pressure is non-linear. At 21,000 atmospheres, the maximum pressure achieved, T_c was lowered from 1.170 to 0.687°K. An analysis of the data indicated that pressures larger than 500,000 atmospheres, most likely infinite pressures, would be required to quench superconductivity in aluminum. (auth)

16138 LATTICE DYNAMICS OF MOLYBDENUM. A. D. B. Woods and S. H. Chen (Atomic Energy of Canada Ltd., Chalk River, Ont. and McMaster Univ., Hamilton, Ont.). Solid State Commun., 2: 233-7(Aug. 1964).

Measurements of the frequency-wave vector dispersion relations for the Δ, Σ, and Λ directions in molybdenum at 296°K using neutron spectrometry showed: vastly different behavior from niobium; striking similarities with tungsten; and a very pronounced anomaly near H, which is perhaps correlated with electronic properties. (auth)

16139 INTRINSIC SEMICONDUCTION IN URANIUM DIOXIDE. H. P. Myers, T. Jonsson, and R. Westin (Aktiebolaget Atomenergi, Nykoping, Sweden). Solid State Commun., 2: 321-2(Oct. 1964).

Electric conductivity and Seebeck coefficient measurements showed uranium dioxide to be an n-type intrinsic semiconductor with an activation energy of 1.3 ev in the temperature range from 1100 to 2000°C. (auth)

16140 SUPERCONDUCTING PROPERTIES OF $AuPb_3$ AND $AuPb_2$. H. L. Caswell (International Business Machines Corp., Yorktown Heights, N. Y.). Solid State Commun., 2: 323-4(Oct. 1964).

The superconducting critical temperatures of $AuPb_3$ and $AuPb_2$ were measured as 4.40 and 3.15°K, respectively. Data available on the superconducting properties of Pb filaments in an Au matrix indicate $AuPb_2$ is readily formed at room temperature due to rapid diffusion of Au into Pb. (auth)

16141 STUDY OF THE $BiFeO_3-LaAlO_3$ SYSTEM. S. A. Fedulov, P. B. Ladyzhenskii, and Yu. N. Venevtsev (Karpov Inst. of Physics and Chemistry, Moscow). Soviet Phys.-Cryst. (English Transl.), 9: 428-31(Jan.-Feb. 1965). Translated from Kristallografiya, 9: 516-20(July-Aug. 1964).

In the $BiFeO_3-LaAlO_3$ system studied, single-phase samples of solid solutions with the perovskite type structure were only found with $LaAlO_3$ concentrations up to 37.5 mol %. In samples with a larger $LaAlO_3$ content, together with the main perovskite phase a certain amount of a second unknown phase was found. For solid solutions of the homogeneous region, the variation of dielectric constant, conductivity, the tangent of the dielectric loss angle, and the specific and spontaneous magnetization with temperature were investigated. On the basis of the results obtained, part of the phase diagram of the system on the $BiFeO_3$ side was constructed. (auth)

16142 CHANGES IN THE INTEGRAL INTENSITY OF X-RAY REFLECTIONS FROM PLASTICALLY DEFORMED MOLYBDENUM DURING LOW-TEMPERATURE RELAXATION. E. P. Germanov and O. N. Shivrin (Petrozavodsk State Univ., USSR). Soviet Phys.-Cryst. (English Transl.), 9: 437-9(Jan.-Feb. 1965). Translated from Kristallografiya, 9: 527-30(July-Aug. 1964).

The integral intensity of x-ray reflections was measured for molybdenum samples subjected to deformation and annealed for 20 hr at 480°C. The annealing resulted in a rise in the reflection intensity. The results are explained by resorption of lattice defects during relaxation. (auth)

16143 CRYSTAL STRUCTURE OF A MAGNESIUM-RICH COMPOUND IN THE PRASEODYMIUM–MAGNESIUM SYSTEM. V. I. Evdokimenko and P. I. Kripyakevich (Lvov Ivan Franko State Univ., Ukrainian SSR). Soviet Phys.-Cryst. (English Transl.), 9: 463-4(Jan.-Feb. 1965). Translated from Kristallografiya, 9: 554-6(July-Aug. 1964).

Studies were made of an Mg–Pr alloy to determine the structure and composition of a magnesium-rich intermetallic compound in it. It was concluded that the compound richest in magnesium has a structure to the $ThMn_{12}$ type and the composition $PrMg_{12}$. (M.C.G.)

16144 PARAMAGNETIC RESONANCE ABSORPTION IN Gd–Ce ALLOYS. Iuliu Pop and V. I. Chechernikov (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 2291-2(Mar. 1965). Translated from Fiz. Tverd. Tela, 6: 2876-7(Sept. 1964).

Resonance absorption was studied in alloys with the following compositions by weight of Gd: 65, 73.8, 80, 90, and 95%. The resonance absorption was studied in the 3-cm range on a spectrometer, which operated on the reflected wave method. The study was made in a temperature range of 20 to 100°C: i.e., all samples were in the paramagnetic state. Curves are given for the dependance of the width of the absorption resonance line ΔH and the spectroscopic splitting g on the composition of the alloy at room temperature. Both curves had a minimum at 95 wt % and a maximum at 73.8 wt % Gd. Curves are given for the dependance of Δ H and the g-factor on the temperature in an alloy containing 95 wt % Gd. It was found that Δ H increases with temperature and the g-factor decreases with temperature. (OTS)

16145 GROWTH KINETICS OF INTERMEDIATE SILICIDES IN THE $MoSi_2$/Mo AND WSi_2/W SYSTEMS. R. W. Bartlett, P. R. Gage, and P. A. Larssen (Philco Research Labs., Newport Beach, Calif.). Trans. AIME, 230: 1528-34(Dec. 1964).

The kinetics of formation of intermediate silicide compounds from $MoSi_2$/Mo and WSi_2/W couples were studied using a cylindrical sample configuration. Concentration profiles of the constituent metals were determined from electron-microprobe analysis of cross-sectioned samples after isothermal diffusion annealing. These data also yielded band widths of phases. Growth of intermediate phases depended on diffusion in them and obeyed a parabolic rate law. The rates of formation of the intermediate phases decreased in the order Mo_5Si_3 > W_5Si_3 > Mo_3Si. Growth rates for the isomorphous phases Mo_5Si_3 and W_5Si_3 had the same activation energy, 43 kcal per mole. (auth)

16146 THE FATIGUE OF BERYLLIUM AT ELEVATED TEMPERATURES. W. Vickers (English Electric Co. Ltd., Whetstone, Eng.). Trans. AIME, 230: 1535-42(Dec. 1964).

Single-point rotating cantilever fatigue tests were carried out at 550 to 650°C on beryllium produced by a variety of fabrication routes. All the specimens gave similar plots of stress against number of cycles to failure but failure occurred at a lower stress range in the hot-pressed material than in the extruded material. A discontinuity or "kink" appeared to exist in the curves and this is considered. A true endurance limit was not evident up to 10^8 cycles. When hot-pressed warm-extruded beryllium was tested at 600°C a relationship $N_f^{3.4}\Delta\epsilon_p = c$, where N_f = number of cycles to failure, $\Delta\epsilon_p$ = plastic strain range, and c = constant, was shown to be applicable for values of $\Delta\epsilon_p > 6.3 \times 10^{-4}$. Further for this material and temperature and for frequencies between 150 and 4500 cycles per min, the variation of number of cycles to failure with frequency obeyed the expression $N = Af^{0.44}$, where N = number of cycles to failure, f = frequency, and A = constant. Examination of the fracture surfaces indicated that they were generally intergranular and in all cases the higher the stress the more irregular was the fracture. Microexamination showed that grain boundary cavities and fine intergranular cracks were associated with the fractures. (auth)

16147 THE STRAIN-RATE DEPENDENCE OF YIELDING AND FLOW IN MOLYBDENUM. R. Norman Orava (Battelle Memorial Inst., Columbus, Ohio). Trans. AIME, 230: 1614-22(Dec. 1964).

The strain-rate behavior of the tensile yielding and flow characteristics of arc-cast polycrystalline molybdenum of >99.97% purity was investigated in the range of 10^{-6} to 10^{-1} sec^{-1} at 243, 293, and 373°K for two grain sizes, 0.027 and 0.098 mm. For 0.098 mm, the strain-rate dependence of the lower yield stress can be described by a straight line of the form $\sigma_y = \alpha + \beta \log \dot{\epsilon}$ over the whole range of strain rates examined. However, for 0.027 mm, the data fit several consecutive linear relationships of the above form. The previous association of these different linear regions with different rate-controlling mechanisms was considered questionable for molybdenum. The semilog strain-rate dependence of the yield stress was consistent with Hahn's model for yielding when the stress dependence of the mobile dislocation density, ρ', was taken into account. Since ρ', from rate-cycling experiments, was found to be relatively insensitive to stress for single crystals, the observed log-log dependence of their yield stresses was also in agreement with the model. A correction for the stress dependence of ρ' changed the activation volume for yielding from a zero to a more realistic inverse function of stress where the Peierls mechanism was believed to be rate-controlling. The grain-size dependence of the lower yield stress was not a monotonic function of strain rate. (auth)

16148 A THERMODYNAMIC ANALYSIS OF THE Ta–C–O, Cb–C–O, AND V–C–O SYSTEMS. Wayne L. Worrell and John Chipman (Massachusetts Inst. of Tech., Cambridge). Trans. AIME, 230: 1682-6(Dec. 1964).

Using recent thermodynamic data for the carbides and oxides of tantalum, niobium, and vanadium, the stable solid phases above 1300°K and at 1 atm CO(g) pressure in each M–C–O system were determined. Pourbaix-Ellingham diagrams were constructed, and are used to estimate the minimum temperatures necessary to obtain these metals by carbothermic reduction under reduced pressures. (auth)

16149 THE SYSTEM CHROMIUM–ZIRCONIUM–OXYGEN AT 1200°, 1500°, AND 1700°C. Seong Kwan Rhee and Michael Hoch (Univ. of Cincinnati). Trans. AIME, 230: 1687-90(Dec. 1964).

The ternary system Zr–Cr–O was investigated at 1200, 1500, and 1700°C. The isotherms at these temperatures were determined by metallographic and x-ray diffraction analysis of carefully selected alloys. (auth)

16150 THE CRYSTAL STRUCTURE OF $TaNi_2$. Bill C. Giessen and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Trans. AIME, 130: 1730-1(Dec. 1964).

An alloy of Ta + 66.7 at.% Ni was prepared by inert-gas arc melting. Specimens were annealed by 15 hr at 1350, 1205, and 875°C with subsequent powdering and stress relief. Micrographs and x-ray analysis showed homogeneous one-phase alloys. It was concluded that either $TaNi_2$ melts congruently or its melting behavior is a transition between the eutectic and peritectic cases. The powder pattern data are presented. $TaNi_2$ was found to be representative of the $MoSi_2$ (C_{11_B}) type. (M.C.G.)

16151 EQUILIBRIUM RELATIONSHIPS IN THE SYSTEM UO_2–Fe_3O_4–O. W. D. J. Evans and J. White (Univ. of Sheffield, Eng.). Trans. Brit. Ceram. Soc., 63: 705-24 (Dec. 1964).

Equilibrium relationships in the partial system UO_2–Fe_3O_4–O of the system U–Fe–O were investigated as a function of temperature and oxygen pressure (0.21 to 0.0088 atm). From the data, ternary isobaric diagrams were constructed showing the composition and phase changes occurring up to 1500°C at five different oxygen pressures. Phase boundaries on the liquidus surface of the ternary space diagram, and solid phase boundaries were constructed by plotting, on the composition triangle, the compositions of the apices of the triangles (monovariant equilibria) established at the various oxygen pressures used. From the oxygen pressure-temperature relationships established for the monovariant transitions observed, expressions were derived for the standard free energies of the corresponding reactions. (auth)

16152 THORIA CERAMICS. M. A. Hepworth and J. Rutherford (Thermal Syndicate Ltd., Wallsend, Eng.). Trans. Brit. Ceram. Soc., 63: 725-30(Dec. 1964).

A review of the technology of dense thoria ceramics is presented, which includes criteria for selection of raw materials, methods of shaping and sintering, and descriptions of the properties and applications of the products. (auth)

16153 THE NIOBIUM (COLUMBIUM)–RHODIUM BINARY SYSTEM. PART I. THE CONSTITUTION DIAGRAM. Donald L. Ritter, Bill C. Giessen, and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 230: 1250-9(Oct. 1964).

Forty-six alloys covering the complete concentration range of the Nb–Rh system were examined by metallographic and x-ray methods; solubility limits of terminal and intermediate phases and transformation and solidus temperatures were determined. There are nine intermediate phases; two eutectic, five peritectic, two eutectoid, and three peritectoid reactions were encountered. The experimental methods and the constitution diagram are described. (auth)

16154 THE NIOBIUM (COLUMBIUM)–RHODIUM BINARY SYSTEM. PART II. CRYSTAL STRUCTURE RELATIONSHIPS. Donald L. Ritter, Bill C. Giessen, and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 230: 1259-67(Oct. 1964).

The crystal structures of eight of the nine intermediate phases in the Nb–Rh system were investigated by x-ray techniques. The following structures occur: $\alpha Nb_3Rh(Cr_3O$ type); $\sigma(\sigma_{Fe-Cr}$ type); α_1(H.T. phase, structure unknown); α_2(AuCu type); α_3 (orthorhombic, analogous to α_1 (Ta–Rh)); α_4 (AuCd type); α_5 (monoclinic, related to samarium type); α_6 (VCo_3 type); and $\alpha NbRh_3$ ($AuCu_3$ type). Structural relationships between the six close-packed intermediate phases are discussed and a comparison with the Nb–Ir, Ta–Rh, and Ta–Ir systems is made. (auth)

16155 THE NIOBIUM (COLUMBIUM)–IRIDIUM CONSTITUTION DIAGRAM. Bill C Giessen, Rosemarie Koch, and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 230: 1268-73(Oct. 1964).

The system Nb–Ir was investigated over the complete concentration range by metallography and x-ray techniques, using forty one alloys. The solubility limits of terminal and intermediate phases and the solidus temperatures were determined. Five intermediate phases were found: α Nb_3Ir, cubic, Cr_3O type; σ, tetragonal, σ_{FeCr} type; α_1, tetragonal, AuCu type; α_2, orthorhombic, isostructural with α_1(Ta–Rh); and α $NbIr_3$, cubic, $AuCu_3$ type. The α Nb_3Ir and α $NbIr_3$ phases melt congruently; three eutectic and three peritectic reactions occur. (auth)

16156 WROUGHT ALLOYS OF THE TUNGSTEN–TANTALUM–MOLYBDENUM–COLUMBIUM SYSTEM. R. C. Westgren, A. Kasak, and E. J. Dulis (Crucible Steel Co. of America, Pittsburgh). Trans. Met. Soc. AIME, 230: 1284-8(Oct. 1964).

The potential of wrought tungsten- and tantalum-rich alloys of the W–Ta–Mo–Nb system was investigated for high-strength structural applications above 2500°F. Appreciable strengthening of tungsten and tantalum, essentially attributable to solid-solution effects, was obtained with binary, ternary, and quaternary alloys. Tensile strengths as high as 67,000 psi were calculated at 3000°F. (auth)

16157 THE Nb–Sn (Cb–Sn) SYSTEM: PHASE DIAGRAM, KINETICS OF FORMATION, AND SUPERCONDUCTING PROPERTIES. H. J. Levinstein and E. Buehler (Bell Telephone Labs., Murray Hill, N. J.). Trans. Met. Soc. AIME, 230: 1314-21(Oct. 1964).

The temperature ranges in which the three intermetallic phases in the Nb–Sn system form were determined and the composition and structure of two of the three phases was established. The kinetics of the formation of Nb_3Sn in cored wire samples was studied in the temperature range from 800 to 1050°C. From 800 to 950°C the rate of formation increased by four orders of magnitude. The rate-controlling step for the formation process in this temperature range appeared to be the diffusion of tin through Nb_3Sn. At higher temperatures a change occurred in the mechanism of the formation process such that up to a temperature of 1050°C the rate of formation of Nb_3Sn did not increase above the rate observed at 950°C. For temperatures below 950°C the current-carrying capacity of the wire increased with increased percent reaction reaching a maximum value when the formation process was 90 to 95% complete. The maximum current-carrying capacity obtainable in this temperature range was independent of the temperature. Above 950°C the current-carrying capacity obtainable in the wire decreased with increasing temperature of formation. A model is proposed, which accounts for the observed behavior. (auth)

16158 EFFECT OF METALLURGICAL STRUCTURE ON THE TENSILE AND NOTCH-TENSILE PROPERTIES OF MOLYBDENUM AND Mo–0.5 Ti. A. G. Imgram (Battelle Memorial Inst., Columbus, Ohio), J. W. Spretnak, and H. R. Ogden. Trans. Met. Soc. AIME, 230: 1345-52(Oct. 1964).

The effect of working reduction, stress-relief annealing, and recrystallized grain size on the tensile and notch-tensile properties of molybdenum and Mo–0.5 Ti was studied. It was found that increasing the amount of working reduction increased the strength and reduced the tendencies toward brittle behavior. Stress-relief annealing did not alter the strength but lowered the transition temperature. Increasing the recrystallized grain size lowered the strength and raised the transition temperature. The notch-unnotch strength ratio began to decrease with decreasing temperature at temperatures below those at which the notched ductility fell to zero for all of the microstructural conditions investigated. (auth)

16159 THE SEGREGATION OF TANTALUM IN IRON IN A LEVITATING ZONE MELTER. B. F. Oliver (United States Steel Corp., Monroeville, Pa.). Trans. Met. Soc. AIME, 230: 1352-7(Oct. 1964).

Equilibrium and kinetic segregation coefficients for the dilute high-temperature system tantalum in iron were experimentally determined in a levitating zone melter. The equilibrium segregation coefficient, k_0, was 0.43 ± 0.03. Planar interface solidification was possible up to a freezing velocity of 4 in. per hr but not at 6 in. per hr. Precise concentration control of the solid was possible over this range of freezing velocities. The momentum boundary layer thickness, δ_m, and the diffusion boundary layer thickness, δ, were such that either $\delta_m > \delta$ or $\delta_m = \delta$ and was a constant, fixed by induction stirring, δ, the diffusion boundary layer, was ≤150 μ. At 400 rpm and 6 in. per hr freezing velocity the cast structure exhibited circular macroporosity and banding concentric with the axis of the rotation of the interface. Electron-beam microprobe analyses indicated that the tantalum content is highest at the center of rotation (1.2/1) and decreases with increasing radius as the fine-grained bands become sharper. This entire structure exhibited microsegregation of tantalum. (auth)

16160 FRACTURE OF MOLYBDENUM. Robert T. Ault (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Trans. Met. Soc. AIME, 230: 1443-53(Oct. 1964).

The nature of fracture in unnotched tensile and notched tensile sheet and round specimens and V-notched and precracked Charpy-type sheet specimens of both wrought stress-relieved and recrystallized molybdenum was investigated over the temperature range of –78 to 300°C. The sharp rise in fracture stress, for unnotched tensile samples, as the temperature was increased above the brittleness transition temperature (T_b), was found to be a result of an increase in flow stress due to plastic constraint and an increased strain rate, which resulted from the onset of necking at T_b. Quasibrittle fracture in notched tensile samples was found to occur when the tensile stress at the elastic-plastic interface, beneath the root of the notch, reached a maximum critical value, which was independent of test temperature over the range from –78 to 25°C, but dependent on microstructure. In the temperature range between 150 and 300°C, unnotched tensile and notched tensile samples alike were found to fracture by a ductile fibrous tearing process, which was discontinuous in nature, as a result of the competition between the processes of tearing, through continued plastic flow, and local work hardening. Results from the V-notched and fatigue-cracked Charpy-type impact tests demonstrated that crack initiation is the governing factor in the low-temperature (–78 to 25°C) fracture process for molybdenum. (auth)

16161 AN INVESTIGATION OF THE YIELD-POINT PHENOMENON IN MOLYBDENUM. G. W. King (Westinghouse Electric Corp., Bloomfield, N. J.) and J. W. Spretnak. Trans. Met. Soc. AIME, 230: 1481-4(Oct. 1964).

Experiments were carried out to determine changes in dislocation densities during discontinuous yielding of molybdenum. Tensile specimens were deformed various amounts up to and beyond the Lüder's strain and the dislocation densities measured over the entire deformed portion of the gage sections. It was found that the dislocation density tends to increase linearly with plastic strain up to and beyond the Lüder's strain. The rate of multiplication at the end of the Lüder's strain increased with temperature up to 185°C and above 225°C it decreased with increasing temperature. (M.C.G.)

16162 $CeCd_6$-TYPE RARE EARTH–CADMIUM ALLOYS. Irving Johnson, Robert Schablaske, Benjamin Tani,

and Karl Anderson (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 230: 1485-7(Oct. 1964).

Investigations of the various rare earth–cadmium alloys disclosed the existence of a compound corresponding to the composition MCd in all but the La–Cd alloy. Lattice constants are given for YCd_6, $CeCd_6$, $PrCd_6$, $NdCd_6$, $SmCd_6$, $EuCd_6$, $GdCd_6$, $ThCd_6$, $DyCd_6$, $HoCd_6$, $ErCd_6$, $TmCd_6$, $YbCd_6$, and $LuCd_6$. (M.C.G.)

16163 THE OMEGA TRANSFORMATION IN ZIRCONIUM–NIOBIUM (COLUMBIUM) ALLOYS. D. J. Cometto, G. L. Houze, Jr., and R. F. Hehemann (Case Inst. of Tech., Cleveland). Trans. Met. Soc. AIME, 233: 30-9(Jan. 1965).

The ω transformation in the Zr–Nb system was studied using x-ray diffraction, dilatometric, resistometric hardness, and metallographic techniques. The phase ω forms in a diffusionless, completely reversible manner on quenching and in a diffusion controlled manner on aging. The temperature at which ω begins to form on quenching was determined as a function of composition and was found to decrease with increasing solute content. The ω phase formed by aging establishes a metastable equilibrium with an enriched β phase. The $\beta/\omega + \beta$ transus was determined for this metastable equilibrium and employed to rationalize retrogression and reversion phenomena observed in these alloys. The decomposition mechanism is discussed in terms of a gradual or continuous transformation from β to the ω state. (auth)

16164 THE RECRYSTALLIZATION BEHAVIOR OF Ni–Ta ALLOYS AND THE ROLE OF FINE PRECIPITATES. Klaus Detert and Joseph Ziebs (Technische Universitat, Berlin). Trans. Met. Soc. AIME, 233: 51-6(Jan. 1965).

The progress of primary recrystallization was studied in alloys of nickel with 0.01, 0.1, and 1.0 at. % Ta. It can be shown that in one particular alloy containing 0.1 Ta and 0.02 O_2 a large grain structure (0.5 mm diameter) could be developed by primary recrystallization in thin sheets, which were cold-worked to 97.5% reduction in thickness. Electron transmission microscopy demonstrated that this phenomena was linked to the occurrence of fine precipitates at subboundaries. A discussion of how fine precipitates can exert under certain circumstances a rather distinct retarding effect on nucleation rate is included. (auth)

16165 INTERNAL FRICTION OF TUNGSTEN SINGLE CRYSTALS. R. H. Schnitzel (Westinghouse Electric Corp., Bloomfield, N. J.). Trans. Met. Soc. AIME, 233: 186-92 (Jan. 1965).

Internal-friction peaks were observed in tungsten single crystals at about 300 and 400°C. The characteristics of these peaks are similar to interstitial peaks observed in other bcc metals; therefore, the origin of these peaks appears to be the Snoek mechanism. The interstitial responsible for the peak at about 300°C was not identified. Carburizing increased the magnitude of the peak at about 400°C; consequently, it appeared reasonable to suppose that the specific interstitial associated with this peak is carbon. The activation energies associated with the peaks as 300 and 400°C were about 35,000 and 45,000 cal per mole, respectively. (auth)

16166 THE INFLUENCE OF POINT DEFECTS ON SOME SUPERCONDUCTING PROPERTIES OF Nb_3Sn (Cb_3Sn). T. H. Courtney, G. W. Pearsall, and J. Wulff (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 233: 212-18(Jan. 1965).

The mechanism of the decrease in transition temperature of Nb_3Sn was studied. Presintered Nb_3Sn powder compacts were heated in a dynamic vacuum at elevated temperatures. Loss of tin resulted from these heat treatments and transition temperature as a function of tin loss was discontinuous at a critical value of tin loss. In general, decreases in transition temperature were correlated with deviations from stoichiometry and presence of vacancies in niobium sites. The effects of vacancy distribution on the physical properties of Nb_3Sn were considered. It was concluded that the close-packed atomic A chain in the A_3B A15 structure must be preserved both in continuity and direction if good superconducting properties are to be obtained. (auth)

16167 PERITECTIC REACTION IN THE SUPERCONDUCTOR Nb_3Sn (Cb_3Sn). Frank J. Bachner (Massachusetts Inst. of Tech., Cambridge), Harry C. Gatos, and Mario D. Banus. Trans. Met. Soc. AIME, 233: 227-30(Jan. 1965).

The portion of the Nb–Sn phase diagram between 75 and 79 at. % Nb at temperatures near the liquidus was investigated by melting alloys of known composition and examining the microstructures resulting when these melts were quenched. The Nb–Sn samples were contained in magnesia sleeves, and were mounted in a high-pressure apparatus. It was found that Nb_3Sn melts by a peritectic decomposition, $Nb_3Sn \rightarrow \alpha Nb + Liq$, and that the composition of the compound Nb_3Sn at the peritectic horizontal lies between 77 and 78 at. % Nb. Analysis of the phases present in the samples was accomplished by anodic staining techniques and an electron-microbeam analyzer. (auth)

16168 PREPARATION OF SINGLE CRYSTALS OF PERITECTICALLY MELTING INTERMETALLIC COMPOUNDS BETWEEN THE RARE-EARTH AND IRON-GROUP METALS. J. F. Nester and J. B. Schroeder (Perkin-Elmer Corp., Norwalk, Conn.). Trans. Met. Soc. AIME, 233: 249-50(Jan. 1965).

A technique is described, by which relatively large single crystals of YCo_5, $NdCo_5$, $DyCo_5$, and YFe_3 were grown. Stoichiometric quantities of the component metals were charged into a boat of alumina, and the boat and its contents were placed in a zone-melting apparatus. The apparatus is evacuated to 5×10^{-5} mm of Hg and back-filled with helium to near atmospheric pressure. A 450-kc radiofrequency generator coupled to a tantalum susceptor was used as a heat source. The components were melted and homogenized. Zone melting was then accomplished by moving the tube through a one- or two-turn radiofrequency coil from one end of the boat to the other. (M.C.G.)

16169 CREEP FRACTURE OF THORIATED NICKEL. B. A. Wilcox and A. H. Clauer (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME, 233: 253-5 (Jan. 1965).

The creep fracture of TD Nickel (Ni + 2 vol % ThO_2) is described as a mechanism suggested for the rupturing process. A constant stress of 18,000 psi was applied for various times over the temperature range from 900 to 1100°C. Micrographs of the specimens are shown. A process for fracture is suggested. (M.C.G.)

16170 INFLUENCE OF INFILTRANT PROPERTIES ON THE STRENGTH OF TUNGSTEN–COPPER COMPOSITES. S. F. Ramseyer and E. A. Steigerwald (Thompson Ramo Wooldridge, Inc., Cleveland). Trans. Met. Soc. AIME, 233: 260-3(Jan. 1965).

The effects of copper infiltrant strength on the strength of a tungsten-base composite were evaluated. The bend strength of porous tungsten infiltrated with copper was determined. Crack morphology and the fracture surface are shown. The effects of temperature were also studied in bend tests and tensile tests. The strength of the Cu–W composite decreased as a function of temperature at the same rate as pure copper. The substitution of an age-hardened Cu-2% Be alloy for copper as an infiltrant in porous tungsten produced a substantial increase in the low-temperature strength and ductility of the composite. (M.C.G.)

16171 REDETERMINATION OF THE SOLID SOLUBILITY OF HOLMIUM IN GOLD. W. J. Wunderlin, B. J. Beaudry, and A. H. Daane (Ames Lab., Ames, Iowa). Trans. Met. Soc. AIME, 233: 436(Feb. 1965).

The eutectic temperature and solid solubility of holmium in gold were determined. Results are presented in graph form. (M.C.G.)

16172 THE COMBINED EFFECTS OF OXYGEN AND HYDROGEN ON THE MECHANICAL PROPERTIES OF ZIRCONIUM. D. G. Westlake (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 233: 368-72(Feb. 1965).

Polycrystalline tensile specimens of various Zr–O–H systems were tested at 298, 178, and 77°K. Solute oxygen and hydride precipitates in quenched systems made individual contributions to the yield strength at 0.2% strain, which combined to produce a resultant strength increment, $\sigma_{0.2} = (\sigma_O^2 + \sigma_H^2)^{1/2}$. Ductility changes, which were observed, can be interpreted in terms of the various oxygen and hydrogen concentrations, testing temperatures, and dispositions of the hydride. (auth)

16173 RGa_3 COMPOUNDS IN SYSTEMS OF RARE-EARTH METAL–GALLIUM. P. I. Kripyakevich, V. Ya. Markiv, and D. I. Dzyana (Lvov State Univ.). Ukr. Fiz. Zh., 9: 908-10(Sept. 1964). (In Ukrainian)

X-ray diffraction was used to investigate the alloys RGa_3 or RGa_2 (R = Y, Tb, Dy, Ho, Er, Tm, Yb, Lu). In the systems Ho–Ga, Er–Ga, Tm–Ga, and Lu–Ga new RGa_3 compounds with a structure of the $AuCu_3$ type were found. The alloys of Y and Tb with Ga contain compounds of RGa_2 (AlB_2 type) in equilibrium with Ga, the alloy of Dy, a compound of unknown composition and structure, the alloy of Yb, a compound isostructural with $EuGa_{3-\delta}$. No compounds of the AlB_2 type were found in the systems Tm–Ga and Lu–Ga. (auth)

16174 MEASUREMENTS OF ACTIVATION ENERGY AND DIFFUSION COEFFICIENTS IN ALUMINUM WITH NMR. Charles Thompson (Marquardt Corp., Van Nuys, Calif.). Z. Angew. Phys., 18: 38-44(Nov. 5, 1964).

The diffusion in aluminum was measured from the motional narrowing of the absorption line in nuclear magnetic resonance. The observations indicate that line narrowing occurs in aluminum. The diffusion coefficient and spin lattice relaxation time were estimated. (auth)

16175 INVESTIGATIONS ON TERNARY OXIDES OF THE TRANSITION METALS. II. THE SYSTEMS TiO_2–NbO_2 AND TiO_2–$TiTaO_4$. Walter Ruedorff and Hans-Hermann Luginsland (Universitat, Tubingen, Ger.). Z. Anorg. Allgem. Chem., 334: 125-41(Dec. 1964). (In German)

TiO_2 and NbO_2 formed an un-interrupted series of mixed crystals $(Ti_{1-x}Nb_x)O_2$. The transition from the TiO_2 to the NbO_2 structure occurred continuously above 75 mole % NbO_2. The mixed crystals with x = 0.2 and less followed the Curie-Weiss's law. The μ_{eff} values for Nb^{4+} calculated for infinite dilution tended to a limiting value of 1.9 B.M. Even at high diamagnetic dilution Nb–Nb doublets occurred in the lattice in a higher concentration than was expected according to probability. The electrical conductivity of NbO_2 ($\varkappa \sim 10^{-4}\ \Omega^{-1}\ cm^{-1}$) increased up to a maximum of $\varkappa \sim 10^{-1}\ Ohm^{-1}\ cm^{-1}$ for a TiO_2 content of 50 mole percent. The limit of the rutile phase $(Ti_{1-x}Ta_x)O_2$ was x = 0.5. At this composition there was titanium(III)–tantalum(V) oxide. The tantalum series compared with the niobium series showed characteristic differences in its magnetic and electrical properties, which came from its constitution. (auth)

16176 INVESTIGATIONS ON THE TERNARY OXIDES OF TRANSITION METALS. III. THE RUTILE PHASE $(V_{1-x}Nb_x)O_2$. Walter Ruedorff and Joerg Maerklin (Universitat, Tubingen, Ger.). Z. Anorg. Allgem. Chem., 334: 142-9(Dec. 1964). (In German)

VO_2 and NbO_2 reacted to form a tetragonal rutile phase $(V_{1-x}Nb_x)O_2$ with x = 0.1 to 0.9. Measurements of the susceptibilities and electrical conductivities showed that the rutile phase is composed of two mixed oxide phases $(V^{4+}_{1-2x}V^{3+}_xNb^{5+}_x)O_2$ with $0 < x < 0.5$ and $(V^{4+}_{1-x}Nb^{4+}_{1-x}Nb^{5+}_{2x-1})O_2$ with $0.5 < x < 1.0$. (auth)

16177 ON THE BINDING RELATION IN SOME T-T- AND T-B-PHASES. Konrad Schubert (Max-Planck- Institut fur Metallforschung, Stuttgart). Z. Metallk., 56: 93-8 (1965). (In German)

A proposal is made for the spacial correlation of outer electrons in the W family, the Cr_3Si family, and the Zr_2Cu family, which is compatible not only with the crystal structures but, also, with some physical properties. From similar conditions proposals may be derived for the spacial correlation of some Laves-phase of the $MoSi_2$ family and of a family containing WAl_4 and Co_2Al_5. (auth)

16178 THEORY OF THERMOMAGNETIC PHENOMENA IN METALS IN A STRONG MAGNETIC FIELD. V. G. Baryakhtar and S. V. Peletminskii. Zh. Eksperim. i Teor. Fiz., 48: 187-203(Jan. 1965).

Formulas are derived for a macroscopic current and heat flow in a body. The kinetic coefficients determining the galvanomagnetic as well as thermomagnetic effects in metals in a strong magnetic field caused by scattering of electrons on a short range potential are calculated. The cases of a degenerate and nondegenerate electron gas are considered for $\omega_H \gg T$ (ω_H is the electron Larmor frequency and T is the temperature). It is shown that the relative amplitude of the oscillations at resonance when the chemical potential $\zeta = \omega_H(N + \frac{1}{2})$ (N is an integer) may become of the order of unity. (auth)

16179 CONTRIBUTION TO THE THEORY OF TRANSFER PHENOMENA IN METALS IN STRONG MAGNETIC FIELDS. A. I. Akhiezer, V. G. Baryakhtar, and S. V. Peletminskii (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 48: 204-21(Jan. 1965). (In Russian)

Various mechanisms of electron and phonon scattering in transverse transfer phenomena in metals in strong magnetic fields are investigated and the role of phonons in heat transfer is elucidated. If $\omega_H\tau_c \gg 1$ (τ_c is the electron mean free path time and ω_H the electron Larmor frequency), kinetic equations may be established for the electron and phonon distribution functions whose particular feature is that they do not contain kinematic terms and that inhomogeneity gradients enter the collision integrals. With aid of these equations general formulas are derived for the kinematic coefficients by taking into account drag of phonons by the electrons. It is shown that in the case of sufficiently pure metals heat is chiefly transferred by phonons but not by electrons. In the quantum case the phonon thermal conductivity should experience the same sort of oscillations as do the electron kinetic coefficients (the difference is only in a shift of positions of the maxima). It is shown that the relative amplitude of quantum oscillations of all kinetic coefficients connected with scattering of electrons on impurities as well as with scattering on lattice oscillations may be of the order of unity. It is demonstrated that the effect of drag of phonons by electrons may appreciably affect the magnitude of the thermal emf. (auth)

16180 LOW-TEMPERATURE SOLID STATE PHYSICS. Some Selected Topics. H. M. Rosenberg. Oxford, Oxford University Press, 1963. 433p. 63s. net.

An account of the major areas of research using low-temperature techniques is presented. Theory for specific heats, electric and thermal conductivities, magnetic and mechanical properties, thermoelectricity, thermal expansion, and the behavior of semiconductors and superconductors is covered, together with experimental observations. (D.C.W.)

16181 WORK FUNCTION CHANGES AND THERMAL DESORPTION OF A MONOLAYER. W. E. Danforth and J. Anderson (Bartol Research Foundation, Swarthmore, Penna.). p.60-7 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

A mathematical theory of thermal desorption of a monolayer is developed, using the thermodynamic relation between changes of desorption rate and changes of the two-dimensional pressure. Combining this with a statistically derived expression for the desorption rate at very low coverage, an expression is derived containing two adjustable constants—the binding energy at zero coverage and an adjustment factor in the surface partition function. The theory is compared with experimental data concerning the system thorium-on-rhenium. Two aspects of this comparison are of particular interest: the shape of the desorption curve is accurately described with no adjustable constants; and the absolute value of the desorption rate at low

coverage is calculable within a factor of two on the assumption of the two-dimensional perfect gas and with no adjustable constants other than the binding energy for a single particle. (auth)

16182 WORK FUNCTION MEASUREMENTS BY THERMIONIC AND PHOTOELECTRIC METHODS ON Ni IN THE PRESENCE OF Cs. B. S. Rump, J. F. Bryant, and B. L. Gehman (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.232-8 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

The work function of Cs-covered Ni was measured under identical conditions by the thermionic and photoelectric methods. The minimum work function of Cs-covered Ni is 1.4 ± 0.1 ev (T_{Cs} = 27 to 145°C, T_{Ni} ~ 450 to 550°K). The results obtained independently by the two methods agree to within 0.05 ev. The measurement of the photoelectric current in the presence of thermionic currents was made possible by the use of a technique employing a modulated light source. (auth)

16183 CYCLIC CHANGES IN THE MECHANICAL CHARACTERISTICS OF BETA-QUENCHED URANIUM DURING ISOTHERMAL AGING. K. Tangri (Atomic Energy Establishment, Trombay, India). p.441-5 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Samples of annealed U were heated to 700°C, held at that temperature for 10 min., and quenched by ice cold water. Then the samples were annealed for various times to 270 sec. at 150, 200, 300, and 400°C. Microhardness and grain size were measured. Sample data for the cyclic variation in hardness and grain size with annealing time are given. The results support the supposition that dislocations are produced during beta-quenching. (M.J.T.)

16184 DISLOCATIONS IN GRAPHITE. A. R. Patel and Om Prakash Bahl (Sardar Vallabhbhai Vidyapeeth, Vallabh Vidyanagar, India). p.501-6 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

An attempt was made to index the dislocations in graphite crystals by studying the etch patterns produced on (0001) cleavage faces of graphite by etching the crystals in the melt of oxidizing agents. (C.E.S.)

16185 METALLIC SOLID SOLUTIONS. A Symposium on Their Electronic and Atomic Structure, Orsay, France, July 1962. J. Friedel and A. Guinier, eds. New York, W. A. Benjamin, Inc., 1963. 642p. (CONF-620702). $19.75.

The 52 papers included cover ordinary alloys, transitional and rare earth impurities, transitional matrices, short-range order, Guinier-Preston zones, and classical and periodic antiphase domain boundaries. Emphasis was placed on developments in the description of the electronic structure of alloys and on their direct bearing on problems of atomic structure. (M.C.G.)

16186 MEASUREMENTS OF THE THERMAL CONTACT RESISTANCE FROM STAINLESS STEEL TO LIQUID SODIUM. Ernst H. W. Schmidt and Ernst Jung (Technische Hochschule, Munich). p.251-63 of "Modern Developments in Heat Transfer." New York, Academic Press, 1963.

In studies of cooling nuclear reactors using liquid sodium, the thermal contact resistance between stainless steel and liquid sodium was measured. Up to 24 contact surfaces were placed in series one behind the other and the drop of temperature along a vertical column of liquid sodium intersected by thin plates of stainless steel was measured. Results are shown in graphs. It was found that the increase in drop of temperature was independent of the number of surface contacts encountered by the heat flow. The contact resistance between well-cleaned liquid sodium and a stainless steel surface was not larger than $10^{-4} m^2$ hr deg/kcal, or smaller than the thermal resistance of a stainless steel layer 0.015 mm thick. (M.C.G.)

16187 REGULARITIES IN THE CHANGES OF ABSORBER MATERIAL PROPERTIES AS A FUNCTION OF ABSORBER CONCENTRATION. K. I. Porthoi. p.283-94 of STI/PUB/81. (In Russian)

Regularities of the change in mechanical and heat-physical properties, as well as in absorption capability, as a function of absorber concentration for thermal and intermediate reactors are studied. The thermal conductivity and the thermal expansion coefficient of absorber alloys containing boron and rare-earth element oxides is reduced with an increase of absorber concentration. Alloys with rare-earth element oxides have a linear law of the thermal expansion coefficient change, while for boron-containing alloys this additive law of changes of properties is disturbed. This is caused by formation under high temperatures of boride phases with various crystal lattices. It is shown that absorption capability, being a function of absorber concentration, is changed along a curve with saturation and depends on the neutron spectrum. A hypothesis on formation of absorption capability maximum under mutual alloying of absorbers is set forth. The hypothesis has wide experimental confirmation on a large number of metal and non-metal absorber system compositions in thermal and intermediate reactors. (auth)

16188 RARE-EARTH-RICH ALLOYS. M. Copeland and H. Kato (Albany Metallurgy Research Center, Ore.). p.295-317 of STI/PUB/81.

The rare earth metals with high thermal-neutron capture cross-sections are of interest for control of power reactors; however, they are susceptible to corrosion. On the premise that non-rare-earth metals may be alloyed with dysprosium, erbium, gadolinium, and samarium, thus improving their properties, the effects of selected alloying additions on the rare earths were studied. The solubilities of zirconium, vanadium, chromium, iron, nickel, copper, aluminum, and silicon in dysprosium, erbium, gadolinium, and samarium, and their effects on the melting points, solid-state transformations and corrosion properties, were studied. Phase diagrams were prepared up to the first rare-earth-rich compound or eutectic, whichever occurred first. On completion of that portion of the work, alloys were made, heat-treated to yield maximum solid solubility of the non-rare earth alloying addition, and oxidation- and corrosion-tested. No improvement of the rare earth metals to oxidation resistance in the atmosphere was observed on alloying; in fact, most additions proved to be deleterious. Aluminum greatly improved the hot-water corrosion resistance of the rare earths tested; other non-rare earth metal additions improved the resistance to a lesser degree. (auth)

16189 STAINLESS STEEL–GADOLINIUM ALLOYS. M. Copeland and H. Kato (Albany Metallurgy Research Center, Ore.). p.333-54 of STI/PUB/81.

Because of the excellent corrosion resistance of stainless steels and the interest in gadolinium as a poison material, alloys of the two compounds were studied. Gadolinium was alloyed with AISI 304 type and chromium-type stainless steels; and then phase relationships, fabricability and properties were studied. The melting points of minor phases in alloys containing low percentages of gadolinium were noted to have a large effect on the structures resulting from equilibrating treatments and fabricability of the steels. When gadolinium was alloyed with the chromium–nickel-type steel, two minor phases, Fe_9Gd and Ni_7Gd, were observed to melt at 1080°C, which limited the heat treatment and fabrication temperatures. Alloys with up to 5 wt % gadolinium were successfully fabricated, and mechanical and corrosion properties were determined. No changes in the mechanical properties or resistance to hot-water corrosion of the steel were observed on alloying with up to about 3 wt % gadolinium. Because of fabrication temperature limitations placed on chromium–nickel steels by the melting point of the minor phases, the effects of gadolinium on chromium steels were studied. Only one minor phase that melted at 1320°C was noted on investigation of the 10 wt % gadolinium isopleth in the chromium–iron–gadolinium alloy system. This property would enable one

to equilibrate and fabricate these gadolinium steels at normally used temperatures. (auth)

16190 MAGNETIZATION DISCONTINUITIES BELOW 1°K IN ALLOYS. B. Dreyfus, Y. Ishikawa, R. Tournier, and L. Weil (Centre d'Études Nucléaires, Grenoble, France). 5p. (CONF-651-53)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Discontinuities in the magnetization curve of Au–6 at. % Co alloy at extremely low temperatures are shown. An attempt was made to separate the reversible from irreversible magnetization for Au–8 at. % Fe alloy. The large hysteresis exhibited by this alloy is discussed. (D.L.C.)

16191 CONTRIBUTION OF MAGNETIZATION (DOWN TO 0.05°K) AND SPECIFIC HEAT MEASUREMENTS TO THE STUDY OF SEGREGATION IN A GOLD IRON ALLOY. O. Bethoux, Y. Ishikawa, J. Souletie, R. Tournier, and L. Weil (Centre d'Études Nucléaires, Grenoble, France). 6p. (CONF-651-52)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Magnetic and specific heat measurements were made on Au–8 at. % Fe alloys with different heat treatments. The Mössbauer effect is also considered, and the effects of segregation on the properties are discussed. (D.L.C.)

16192 BUCKLING STRENGTH OF CURVED BERYLLIUM PANELS IN COMPRESSION. M. J. Rebholz (Lockheed Missiles & Space Co., Sunnyvale, Calif.). 26p. (CONF-729-5)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The forward structure of the Agena spacecraft was redesigned to use cross-rolled beryllium sheet as structural panels. Three different methods were used to fabricate twenty unstiffened and three stiffened, curved, beryllium panels. The panels were tested under axial compression loading to determine their critical buckling stress and to verify the design analysis. Test results are presented and compared with analytical values found by a semi-empirical method developed in recent NASA studies. It was concluded that the behavior of wide, curved beryllium panels under axial compression can be adequately predicted using the semi-empirical NASA method with the modified β factor. (P.C.H.)

16193 EFFECT OF TRACE IMPURITIES ON THE C.R.S.S. FOR (0001) SLIP IN BERYLLIUM. C. E. R. Tristam and A. Moore (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). 16p. (CONF-729-7)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Single crystals $\frac{1}{4}$ in. in diameter and 99.975% pure were obtained from vacuum cast and extruded Pechiney S.R. grade metal by vertical zone refining in an argon atmosphere using up to 6 zone passes. The crystals, characterized by a critical resolved sheer stress (c.r.s.s.) for (0001) slip ~400 psi at 20°C, were recontaminated with carbon by diffusion from the free surface at 1000°C and as a result the c.r.s.s. for (0001) slip increased to 1770 psi at 20°C. This high level of c.r.s.s. is more characteristic of beryllium of 99.90% pure and underlines the possible importance of carbon relative to other impurity elements. Furthermore recontamination in a nitrogen atmosphere was also attempted but without a significant increase in c.r.s.s. for slip. The role of carbon both as a solute and as a precipitate in restricting deformation in single and poly-crystals is considered and the possible effects of its removal suggested. A possible way of reducing the carbon content in beryllium by heating in flowing hydrogen is proposed. (auth)

16194 SLIP IN BERYLLIUM SINGLE CRYSTALS COMPRESSED ALONG THE C-AXIS NEAR 200°C. D. Beasley and A. Moore (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). 12p. (CONF-729-8)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The occurrence of wavy pyramidal slip in beryllium single crystals compressed parallel to the C-axis and its possible relationship to the brittle-ductile transition in polycrystals, has been confirmed for specimens of Pechiney metal ≠99.85 wt % Be zone refined twice and ≠99.95 wt % Be zone refined 6 times and tested over the range 148-350°C. A hypothetical model was used to demonstrate that the critical resolved sheer stresses for $(11\bar{2}5)$ slip observed in a specimen compressed at 180°C was between 19,000 and 11,700 psi, and that the observed traces could not be attributed to $(11\bar{2}5)$ slip with Burgers vector in the basal plane, cross slip with $(10\bar{1}0)$ $<11\bar{2}0>$, and cross slip on $(10\bar{1}0)$ and (0001) planes in $<11\bar{2}0>$ direction. Large differences in the applied lead required to initiate pyramidal slip in different specimens over the range 148-350°C suggest that its occurrence is purity dependent. Possible further evidence for impurity locking, observed as strain ageing effects, is also discussed. (auth)

16195 THERMAL CONDUCTIVITY OF MATERIALS AND REFRACTORY MATERIAL ASSEMBLY USED IN THE JET OF MAGNETOHYDRODYNAMIC CONVERSION. X. Nguyen Duc and D. Neant (Commissariat à l'Energie Atomique, France and Institut Francais du Pétrole, France). 11p. (CONF-640701-11). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

A comparative study was made of the thermal conductivity of ZrO_2-base materials as a function of the temperature when the samples are in block form, powdered, and in thin plates. The methods and apparatus used for the measurements are described. The results showed the important role played by air on the apparent conductivity of porous samples. The best insulating qualities were obtained with the largest pores and smallest grains up to a critical value of the apparent density. The use of powdered refractories presents great practical difficulties in complicated assemblies and the plates are often too fragile. (J.S.R.)

16196 TECHNOLOGICAL AND EXPERIMENTAL STUDY ON THE WALL CONDUCTION AND INSULATION FOR MHD GENERATORS. A. Bĕkiarian, R. Graziotti, and A. de Montardy (Electricité de France, Paris). 8p. (CONF-640701-12). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Tests were made to define the behavior of electrodes of copper, inconel, and rhodium operating at different surface temperatures. Insulating studies were also made on walls consisting of alternating pieces of copper and insulation plates. The tests were made in the presence of seeded combustion gas. The results showed that under practical conditions of utilization, the behavior of metallic electrodes can be summarized by the value of the potential observed in the presence of an ionized gas of known characteristics. (J.S.R.)

16197 LONG-DURATION TESTS OF REFRACTORY MATERIALS UTILIZED FOR THE CONSTRUCTION OF MAGNETOAERODYNAMIC GENERATORS. A. Dubois and R. Creuse (Compagnie Generale d'Electricité, Marcousis, France). 8p. (CONF-640701-14). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The qualities required for the refractory materials of the MAD conversion chamber were summarized, and the test methods available in the laboratory were outlined. Tests made on uncooled and water-cooled shock tubes of copper and of stainless steel were reported. The results showed that if the walls remain sufficiently insulated from the plasma, it is preferable to effect the combustion in an excess of oxygen with respect to the stoichiometric proportion. Although some elements insulated electrically by an Al_2O_3 layer have faults, it seems that the metallic walls can be separated from the plasma by a refractory layer. (J.S.R.)

16198 ANOMALOUS PROPERTIES OF DILUTE MAGNETIC ALLOYS. Jun Kondo (Electro Technical Lab., Tokyo). 7p. (CONF-651-50)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Dilute alloys of transition metals in noble metals show anomalous properties at low temperatures, particularly a resistance minimum and a large thermoelectric power. The theory of these anomalous properties is considered in some detail. The cross section of scattering due to impurity atoms is shown to contain an even part and an odd part, the latter causing the thermoelectric power. The second Born approximation is shown to have an imaginary part in the impurity potential. Equations are derived which show that the thermoelectric power is independent of impurity concentration, is constant at low temperatures, and tends to zero when the lattice resistance dominates over the residual resistance. (D.L.C.)

16199 GRAIN BOUNDARY AND SURFACE INFLUENCE ON MECHANICAL BEHAVIOR OF REFRACTORY OXIDES—EXPERIMENTAL AND DEDUCTIVE EVIDENCE. S. C. Carniglia (Atomics International, Canoga Park, Calif.). 90p. (CONF-641116-1)

From Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C.

A model for grain boundaries of MgO, Al_2O_3, and BeO is postulated, and tested against empirical elastic, plastic flow, and fracture data. Descriptions of the various atomistic processes are given, and found to be consistent with experience. New conclusions were reached concerning the strengthening of ceramics. (auth)

16200 TRACER DIFFUSION STUDIES IN MOLYBDENUM. J. Askill (Univ. of Reading, Berks, Eng.). 11p. (CONF-691-9)

From Conference on Fusion of Body-Centered Cubic Materials, Gatlinburg, Tenn., Sept. 1964.

Self and solute diffusion in molybdenum were studied in the temperature range from 1850 to 2350°C using the radioactive isotopes ^{99}Mo, ^{60}Co, and ^{95}Nb, and the serial sectioning method of analysis. For self diffusion the results on polycrystalline material are expressed by $D = 0.5^{+0.7}_{-0.3}\, e^{-91.2\pm7.4}/RT$ and for single crystals $D = 0.1^{+0.2}_{-0.1}\, e^{-97.2\pm2.6}/RT$. The solute diffusion results on polycrystalline material are expressed by $D = 18^{+20}_{-9}\, e^{-106.2\pm3.8}/RT$ for cobalt and $D = 14^{+14}_{-7}\, e^{-108.1\pm3.2}/RT$ for niobium. It was found that an argon atmosphere for the heat treatments has an appreciable effect on the tracer diffusion rates of ^{60}Co in Mo. The argon environment resulted in a reduction of the lattice diffusion coefficients by a factor that varied from 6.3 at 1850°C to 2.8 at 2350°C, and also an enhancement of grain boundary diffusion. (auth)

16201 SELF DIFFUSION IN CHROMIUM. J. Askill (Univ. of Reading, Berks, Eng.). 11p. (CONF-691-6)

From Conference on Fusion of Body-Centered Cubic Materials, Gatlinburg, Tenn., Sept. 1964.

Self diffusion in Cr was studied in the temperature range from 1000 to 1550°C in order to resolve some uncertainties in the published data of a number of recent studies covering various parts of this range. The results can be represented by the normal temperature dependence with constant values of activation energy and frequency factor. The results obtained were in good agreement with those of Hagel for the temperature range from 1200 to 1600°C and indicated that at temperatures below 1200°C grain boundary diffusion is largely responsible for the deviations in other results. Self diffusion in Cr did not therefore exhibit the nonlinear dependence of logD on 1/T recently established for the bcc transition metals Ti and Zr. (auth)

16202 STUDIES OF THE THERMODYNAMIC PROPERTIES OF COMPOUNDS OF THE LIGHT METALS. Michael A. Greenbaum and Milton Farber (Maremont Corp., Pasadena, Calif.). 12p. (CONF-641208-2).

From 3rd Conference on Performance of High Temperature Systems, Pasadena, Calif.

High-temperature physical and thermodynamic data on compounds of the light metals, notably beryllium, aluminum, boron, and magnesium were obtained using equilibrium thermodynamic techniques. Several experimental techniques were developed and two mathematical treatments of experimental data were derived. A summary of this work is presented. (auth)

16203 THE ELECTRICAL RESISTIVITY AND THERMAL CONDUCTIVITY OF LIQUID ALKALI METALS TO 2000°F. F. Roehlich, Jr. (MSA Research Corp., Callery, Penna.). 21p. (CONF-641018-1).

From the Electrochemical Society 126th Meeting, Washington, D. C.

The temperature dependence of the electric resistivity to 2000°F of the five alkali metals and two alkali metal alloys was investigated experimentally and theoretically. A parallel resistance method was used with a modified Kelvin bridge. A correlation was made between electrical resistivity and thermal conductivity based on both the theoretical Wiedemann-Franz law and the empirical equation established by C. T. Ewing. The experimental resistivity apparatus and procedure are described and the results discussed. Generally good agreement was found between the measured and the resistivity-predicted values of thermal conductivity. Previous results with lithium were substantiated. Hence the variation of thermal conductivity with temperature for each metal is shown to be rather accurately predictable by its electrical analog. (auth)

16204 SOME OBSERVATIONS OF THE DEFORMATION MODES OF POLYCRYSTALLINE HAFNIUM AND ZIRCONIUM. D. H. Baldwin and R. E. Reed-Hill (Univ. of Florida, Gainesville). 3p. (CONF-524-17); (TID-21086)

From American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964.

Torsional straining of swaged, polycrystalline Hf and Zr wires was carried out at 350, 25, and -196°C. Two twin modes and four slip planes were identified for Hf, while Zr exhibited two new slip planes and a greater tendency to deform by twinning than Hf. The results are in agreement with predictions. (D.L.C.)

16205 THE SOFT X-RAY EMISSION BAND SPECTRA OF METALS AND ALLOYS. Brian J. Thompson and Paul F. Kellen (Technical Operations Research, Burlington, Mass.). 19p. (CONF-640612-1)

From 15th Annual Mid-America Symposium on Spectroscopy, Chicago.

The effect of alloying on the x-ray emission band spectra of metals is discussed with consideration of some typical spectra and of interpretation and measurement of spectra. (D.C.W.)

16206 URANIUM BASE ALLOY. M. H. Binstock and H. E. Kline (to U. S. Atomic Energy Commission). U. S. Patent 3,170,788. Feb. 23, 1965.

A uranium-base alloy fuel material was developed, which has improved high-temperature deformation resistance. This alloy contains 1.5 to 6 wt % molybdenum, 0.1 to 1 wt % aluminum, 0.2 to 1 wt % aluminum and silicon in which either the aluminum or the silicon is at least 0.1 wt %, and the remainder uranium. (AEC)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry.

Refer also to abstracts 15953, 16016, 17337, and 17361.

16207 (AECL-2138) A DEVICE FOR PREPARING PRIMARY REPLICAS BY REMOTE MEANS. J. R. Kench and D. H. Rose (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1964. 22p. Dep.; $0.50(AECL).

It was found necessary to design and build a device for stripping polyvinyl chloride replicas, suitable for microscopical examination, from the surfaces of irradiated fuel specimens. A detailed description of the device and full working instructions are given. (auth)

16208 (EURAEC-1249) STUDIES ON THE INFLUENCE OF NEUTRON IRRADIATION ON THE PROPERTIES OF ZrNb3Sn1. Final Report. W. Jung-Koenig, H. Richter (Met-

allgesellschaft A. G., Frankfurt am Main (West Germany)); W. Spalthoff, and E. Starke (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht, (West Germany)). Oct. 14, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 092-62-7 RDD. 75p. Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

Samples of $ZrNb_3Sn_1$ and reference samples of Zircaloy-2 were exposed to different neutron irradiation in the FRG-1 swimming-pool reactor at about 45°C. At the test temperatures of 20 and 300°C, the irradiation resulted in an increase in the yield strength and a drop in the elongation which was roughly the same, expressed as a percentage, for both alloys. The extent of the changes in the mechanical properties increases with the integrated fast neutron flux received (>1 Mev). With rising integrated neutron flux, however, the mechanical properties approach saturation values. At a test temperature of 450°C no irradiation effect is observed. The irradiation has no effect on the reduction in the cross-sectional area on rupture. The notch-impact strength of $ZrNb_3Sn_1$ is increased by irradiation. Anneals at 300–360°C after irradiation lower the notch-impact strength since hardening processes take place. Corrosion tests under irradiation in a water/steam atmosphere at 400°C in irradiation capsules showed an increase by a factor of two in the corrosion attack on $ZrNb_3Sn_1$ on the basis of the weight increase measured. A somewhat greater increase in the corrosion was noted in the case of Zircaloy-2, the hydrogen pickup rising more rapidly than the weight increase during the tests under irradiation, which was, however, found to be due to the radiolytical decomposition of the water. Tensile test samples of $ZrNb_3Sn_1$ corroded under irradiation showed only slight changes in their mechanical properties in comparison with non-corroded and non-irradiated samples. (auth)

16209 (HW-84281(p.3.1-16)) NEUTRON DAMAGE TO METALS. J. L. Brimhall, H. E. Kissinger, J. J. Laidler, B. Mastel, and K. R. Merckx (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

A program directed toward establishing the combined effect of impurities and neutron irradiation on the properties and structure of specific metals, and studying thermally activated recovery processes is reported. Loops present in neutron-irradiated Mo containing C were found to grow sufficiently in size during postirradiation annealing to permit identification by electron microscopy. The large loops are interstitial in character with a loop plane of (111) and a Burgers vector of a/2 [111]. Preliminary tensile loading experiments performed in the electron microscope showed that channels free of radiation-induced, clustered defects actually form in thinned Mo. A computer program is being developed for analyzing electron diffraction contrast associated with displacement and strain functions of defects in lattices. Analysis of x-ray-diffraction line shapes of irradiated Mo led to the conclusion that distortion rather than particle size effects is responsible for the broadening of lines. Changes in line shapes and lattice parameter due to increasing irradiation dose are explained on the basis of a change from a uniform to a heterogeneous distribution of defects. Additional results on the spacing and character of slip lines formed on the surface of irradiated Mo single crystals were obtained. (auth)

16210 (HW-84281(p.3.17-50)) SWELLING OF IRRADIATED FISSIONABLE MATERIALS. R. D. Leggett, J. L. Brimhall, B. Mastel, and H. A. Taylor (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The effect of fission rate and temperature on the behavior of U specimens during irradiation are being investigated. The higher damage rate qualitatively requires a slightly higher temperature than normal for completion of recovery processes. The first controlled-pressure (1000 psi), controlled-temperature (450°C) capsule containing high-purity and alloy specimens of U was charged in a reactor and is operating satisfactorily. A second controlled-pressure capsule was constructed and will be used to investigate the effect of pressure at an irradiation temperature of ~575°C. Postirradiation examination of a number of specimens with different metallurgical histories and alloy contents, all irradiated in temperature-controlled capsules, has continued. Alloy additives of Fe + Al and Fe + Si reduce the swelling of high-purity U specimens. Optical and electron metallography of porosity corroborated immersion density estimates of porosity in the specimens. A large proportion of the porosity observed in the Fe–Al and Fe–Si alloys of U is associated with twin bands. Grain size was ruled out as an important variable influencing the behavior of high-purity U specimens irradiated under conditions leading to crystallographically aligned tearing. Foil specimens of dilute Fe–Si alloys of U were thinned for transmission electron microscopy. Particle sizes and their number agree qualitatively with results previously obtained by replica techniques. A cursory examination of x-ray-diffraction line-broadening in U as a function of irradiation and postirradiation annealing was initiated. Considerable broadening of (111) and (112) was detected; (021) and (002) show practically no broadening. (auth)

16211 (HW-84281(p.4.1-5)) ALLOY SELECTION. T. T. Claudson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

As part of a coordination effort in a program to determine radiation effects on reactor materials specifications were written for test materials, and quantities of AISI 316 SS bar, sheet, and plate were ordered. Tensile specimens of Incoloy 800, Inconel 600, Inconel 625, and Inconel 718 were irradiated at 50, 280, 580, and 740°C to exposures up to 8×10^{20} nvt. During the past quarter specimens of these alloys irradiated at 740°C to an exposure of 9×10^{19} nvt (E > 1 Mev) were tested at room temperature. Increases in strength were found in all alloys except Incoloy 800 where a small decrease in yield strength was observed. Slight improvement in room temperature ductility was also found in the Incoloy 800 and Inconel 625 specimens. To determine any microstructural changes due to irradiation, a broken tensile specimen of Inconel 600 material described above was sectioned for metallographic and electron microscopy examination. Comparison of this material to that of a non-irradiated control specimen is planned. (auth)

16212 (HW-84281(p.4.6-7)) IN-REACTOR MEASUREMENTS OF MECHANICAL PROPERTIES. J. A. Williams, D. H. Nyman, and J. W. Carter (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Creep tests on annealed AISI 304 SS were completed at 500 and 600°C and at a stress level of 20,000 psi. The preliminary data from these two tests indicate that at 600°C the in-reactor creep rate was 8.9×10^{-6} hr^{-1}. The out-of-reactor control test showed a minimum creep rate of 2.1×10^{-5} hr^{-1}. At the lower temperature the creep rate was found to be lower than the measuring capabilities of the test apparatus. In-reactor activation energy tests were also completed, the results of which are now being evaluated. A new test facility is being developed at the Plutonium Recycle Test Reactor. Modifications of an existing test capsule to fit this new facility were started. (auth)

16213 (HW-84281(p.4.8-13)) IRRADIATION FACILITIES OPERATION. J. E. Irvin (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

With the conclusion of ETR Cycles 64 and 65, over 400 tensile specimens were discharged from the ETR. These specimens were Zircaloy-2, stainless steels, nickel-base alloys, and refractory metal alloys, and were irradiated in both the G-6 and G-7 positions of the ETR core. Several unirradiated control specimens were also discharged from the out-of-reactor loop. H_2 was added to the G-7 Hot Water Loop during ETR Cycle 65 to reduce the free O_2 content. A special hanger assembly was fabricated to provide an additional level of quadrant space in a lower flux region and to provide for the irradiation of the tube sections. Data from irradiations performed during this cycle indicate a reduction in oxidation. However, weight gains for the in-reactor exposures are still an order of magnitude greater than for

equal exposures in an out-of-reactor environment. Several tensile specimens fabricated from tubes containing an Inconel 600-to-Zircaloy-2 transition joint are currently being irradiated in the G-7 Hot Water Loop. These specimens were fabricated from tubes with transition joints formed both by explosive welding and coextrusion processes. Goal exposure for these irradiations is 5.0×10^{20} nvt (>1 Mev). Irradiated specimens, unirradiated controls, and as-fabricated specimens will be tested at room temperature and at 288°C. (auth)

16214 (HW-84281(p.4.14-15)) IRRADIATION DAMAGE TO ZIRCALOY-2. J. E. Irvin (General Electric Co., Richland, Wash. Hanford Atomic Products Operation.

Tensile tests were performed on specimens fabricated from N-Reactor Zircaloy-2 tubes and irradiated in the G-7 Hot Water Loop at 290°C. Tests were performed at room temperature and 300°C on irradiated specimens and unirradiated controls exposed in the out-of-reactor loop. At an exposure of 5.64×10^{20} nvt (E > 1 Mev), the room temperature 0.2% yield strength increased 65% and the uniform elongation decreased 74%. For the same exposure the 300°C 0.2% yield strength increased 56% and the uniform elongation decreased 75%. Generally, the tubes from three different vendors behave similarly after irradiation although each was fabricated under different conditions. Test results on control specimens exposed for over 1600 hours indicate an increase in the yield and ultimate strength of about 2000 to 5000 psi with no measurable change in elongation. Tests are being conducted on control specimens exposed for over 5000 hours. (auth)

16215 (HW-84281(p.4.16-18)) IRRADIATION DAMAGE TO NICKEL-BASE ALLOYS. I. S. Levy and K. R. Wheeler (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Specimens of Hastelloy X-280 are being prepared in four levels of cold work and two different aging conditions to determine the effect of controlled precipitation of carbides upon stress-to-rupture and tensile properties after irradiation. Tests showed that the differences in tensile properties reported earlier for Inconel X-750 specimens heat treated in He-filled quartz ampules and in air were due primarily to variations in grain size caused by differences between the thermal conductivity of air, on the one hand, and He and the quartz ampule, on the other. (auth)

16216 (HW-84281(p.4.19-24)) DAMAGE MECHANISMS. F. A. Smidt (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Testing of Ferrovac E and zone-refined Fe irradiated to 5×10^{18} nvt (>1 Mev) was completed and the data were analyzed by applying the theory of thermally activated flow. It was shown that the defects introduced by neutron bombardment become the rate controlling barriers for dislocation movement near room temperature but have no effect on the rate controlling process below 200°K. In addition, a change in the activation volumes with strain indicates the dislocations are interacting with the defects and removing them from the lattice in localized areas as in the case of channeling observed in irradiated Mo. This phenomena also explains the decrease in work hardening observed in irradiated Fe. A temperature independent increase in the long range internal stress fields was also produced by the irradiation and accounts for the increase in yield stress observed in Fe. Annealing irradiated samples of both materials at 350°C for 3 hr eliminated most of the irradiation produced property changes described above. The mechanism apparently is an agglomeration of defects into sizes or geometries which produce less strain in the lattice and of a size insurmountable by thermal activation of dislocations. (auth)

16217 (HW-84281(p.5.31-5)) N-REACTOR CORROSION AND HYDRIDING. D. W. Shannon (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

An attempt was made to account for in-reactor hydride failures of Zircaloy components at low water temperatures reported in the literature. Conceivably at low temperatures oxide defects might not heal before hydriding occurred. An experiment performed to test this possibility is described. An in-reactor evaluation of Ni-plated Al-clad fuel is in progress. Plated fuel and dummies were heat treated to establish a diffusion bond between Al and Ni plate. It is anticipated the heat treatment will eliminate plate sloughing observed in previous in-reactor exposures. (auth)

16218 (HW-SA-3626) IRRADIATION TESTING IN SUPPORT OF THE Pu-RECYCLE DEMONSTRATION EXPERIMENT IN EBWR. W. J. Bailey (Hanford Atomic Products Operation, Richland, Wash.). Nov. 9, 1964. Contract AT(45-1)-1350. 30p. (CONF-654-33). Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Vibrationally compacted $UO_2-1.5$ wt % PuO_2 rods are being irradiated in the EBWR to obtain information on the use of Pu as a fuel in light-water thermal reactor systems. Some capsules were discharged at 1.9×10^{20} fissions/cm^3 and examined. Photomacrographs and autoradiographs of sections of the capsules are used to show the effects of rod power and exposure. Fission gas release values were also measured. The capsule tests indicate that the full-size UO_2-PuO_2 rods will perform satisfactorily in the 42-Mw EBWR up to 2.5×10^{20} fissions/cm^3. (D.L.C.)

16219 (LA-DC-6753) IRRADIATION OF MOLTEN Pu-Co-Ce FUELS IN CONTACT WITH SODIUM. J. A. Basmajian (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 12, 1964. Contract [W-7405-eng-36]. 10p. (CONF-641117-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 19th High-Temperature Fuels Committee Meeting, Thousand Oaks, Calif.

Two capsules containing 33 wt % Pu-56.5 wt % Ce-10.0 wt % Co alloy fuel in contact with sodium, were irradiated in the LAMPRE. One capsule was cut into sections, and radiochemical analyses were made of each section. The distributions of fission products, Pu, and Na among the sections are shown. Some preliminary results are also presented for the second capsule. (D.L.C.)

16220 (NUMEC-3432-6) IRRADIATION TESTING OF UO_2-PuO_2 FUELS. Quarterly Progress Report, October 1-December 31, 1964. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-3432. 6p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

After a brief outline of the objectives of the program for the irradiation of UO_2-PuO_2 compositions for fast breeder reactors and for plutonium recycle, the following progress is reported: shipment and insertion of instrumented capsules into GETR, coating of UO_2-PuO_2 particles with tungsten and their fabrication into fuel elements, and capsule heating rates and interface temperatures. (D.L.C.)

16221 (ORNL-3767) RADIATION DAMAGE IN CADMIUM SULFIDE AND CADMIUM TELLURIDE (thesis). Rowena O. Chester (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 132p. Dep.; $4.00 (cy), 3(mn) CFSTI.

Submitted to Univ. of Tennessee, Knoxville.

The effects of irradiation with ^{60}Co gamma rays, ^{137}Cs gamma rays, and thermal neutrons on the carrier concentration in n-type CdS and CdTe were studied by means of Hall effect measurements. Irradiation of these materials did not introduce any new energy levels in the range from 0.02 to 0.2 ev below the conduction band (the range accessible by experiment) although the density of levels in this interval initially present was altered and, under certain conditions, deep lying acceptor states were produced. The most significant observation was the change in the nature of the effect as the energy of the incident gamma rays was changed. For example, ^{137}Cs photons introduce acceptors in CdS and donors in CdTe while ^{60}Co photons have the inverse effect. Atomic displacement calculations indicate that the lower energy ^{137}Cs photons should preferentially displace sulfur atoms in CdS and cadmium atoms in CdTe, the opposite is calculated for ^{60}Co. Hence, these studies indicate that the net result of displacement of the electronegative constituent is acceptor introduction with donor

introduction resulting from displacements in the cation sublattice in these II-VI compound semiconductors. (auth)

16222 (WAPD-TM-471) RADIATION DAMAGE EXPOSURE AND EMBRITTLEMENT OF REACTOR PRESSURE VESSELS. K. Shure (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1964. Contract AT(11-1)-Gen-14. 67p. Dep.; $3.00(cy), 2(mn) CFSTI.

The procedure used to obtain estimates of the changes in the ductile-to-brittle transition temperature of ferritic steel due to neutron irradiation were examined. These estimates are shown to depend on the neutron spectrum employed in the interpretation of the activation of the fast neutron monitor associated with radiation damage specimens and on the damage cross section model used in evaluating irradiation exposures. A damage model which accounts for neutron spectral differences between irradiation locations was used to obtain a physically more meaningful measure of exposure than the usually cited neutron flux above 1 Mev (nvt > 1 Mev). Available data on the change in transition temperature for A302B pressure vessel steel were correlated with this newer exposure parameter. A physically reasonable estimate of the functional dependence of this correlation was fit in a least squares sense to these data and one-sided tolerance limits are ascribed for use by reactor designers. (auth)

16223 (WCAP-6065) MELTING POINT OF IRRADIATED URANIUM DIOXIDE. J. A. Christensen, R. J. Allio, and A. Biancheria (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1965. Contract AT(30-1)-3017. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

The melting point of nearly stoichiometric, sintered UO_2 irradiated for 2000, 9500, 13,500, 18,000, 29,500, and 52,000 Mwd/MTU was measured optically using the Mendenhall "V" technique. A nearly linear decrease at a rate of 32°C/10,000 Mwd/MTU from 2800°C at zero exposure to 2640°C ± 30°C at 52,000 Mwd/MTU was observed. (auth)

16224 (AI-Trans-73) DETERMINATION OF THE ACTIVATION ENERGY OF LATTICE DEFECT MOBILITY BY THE LINEAR HEATING RATE. M. Balarin and A. Zetsche. Translated by Anthony Cornell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.), from Phys. Status Solidi, 2: 1670-82 (1962). 20p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A new methodology of evaluation of experimental annealing curves using linear heating rate is proposed, especially in order to determine the energy of activation for the mobility of lattice defects. The familiar kinetic equations for monomolecular reactions were used as a starting point. This methodology permits a more accurate and objective evaluation than the method employed until now with the linear heating rate. The applicability to the most heterogeneous physical problems is demonstrated. (auth)

16225 THE RECOVERY OF COLD-WORKED AND NEUTRON-IRRADIATED NICKEL IN STAGES III AND IV. F. Bell (Max-Planck-Institut fur Eisenforschung, Dusseldorf, Ger.). Acta Met., 13: 363-74(Mar. 1965). (In German)

The release of stored energy of cold-worked or neutron-irradiated nickel was studied between room temperature and 300°C. Stage III was observed near 100°C, and stage IV near 250°C. An activation energy of 0.98 ± 0.08 ev and second order kinetics were found in stage III for the initial stages of recovery; stage IV exhibited an activation energy of 1.40 ± 0.15 ev and a logarithmic time relationship. The data were interpreted in terms of various processes. In stage III it was assumed that interstitials recombine with vacancies or are trapped at impurity sites. In stage IV it was concluded that vacancies associate into vacancy clusters. These processes are in agreement with the experimental time relationships. These concepts are also supported by electron microscope transmission studies. From the total amount of released heat the defect concentration after cold work and after neutron irradiation were estimated. (auth)

16226 ANTIFRICTION CHARACTERISTICS OF NEUTRON-IRRADIATED STEEL. E. A. Markovskii and M. M. Krasnoshchekov. At. Energ. (USSR), 18: 72-3(Jan. 1965). (In Russian)

Antifriction properties of carbon steel were studied as a function of neutron irradiation doses. Four specimens annealed at 850 to 870°C and quenched at 850°C were irradiated with neutron fluxes from 10^{16} to 10^{20} n/cm² in a vertical reactor column. The specimens irradiated by 10^{18} n/cm² exhibited lower wear resistance than the control specimens. Irradiation with 10^{16} and 10^{17} n/cm² reduced the hardness from HV 756 to HV 514 indicating that the neutron bombardment and not the thermal treatment is the major factor in reducing the wear in steel. The results showed that small irradiation doses reduced the hardness in annealed specimens. Further irradiation improved the wear resistance of steel while the friction characteristics were not affected. (R.V.J.)

16227 ON THE ROLE OF THERMAL PEAKS IN FORMATION OF LATTICE DEFECTS. L. G. Gurvich and N. S. Bespalova. At. Energ. (USSR), 18: 76-7(Jan. 1965). (In Russian)

The concept of thermal and shift peaks appearing with thermal excitations during fast particle energy transmission was introduced by F. Seitz et al. (Displacement of Atoms during Irradiation in Solid State Physics, 1956). Calculations showed that this energy is sufficient for heating to thousands of degrees an area with a radius of tens of angstroms containing not more than one thousand atoms. The thermal and shift peak models are used for resolving the general thermal conductivity. (R.V.J.)

16228 ANISOTROPY OF ATOMIC DISPLACEMENTS IN NEUTRON-IRRADIATED Fe, Cu, AND W. V. A. Il'ina, V. K. Kritskaya, and B. V. Sharov. Dokl. Akad. Nauk SSSR, 158: 843-5(Oct. 11, 1964). (In Russian)

Radiation damage in a crystal lattice was studied by measuring the integral intensities of x-ray interferences. Polycrystalline samples were used. To ensure a fine-crystalline structure of the samples, they were prepared from fine powder. The materials investigated were U-9 brand carbon steel (α phase), copper, and tungsten. All samples were irradiated in a reactor at a fast neutron dose 10^{20} n/cm², the sample being kept at 80°C. The x-ray counting rates were measured with a scintillation-counting setup in molybdenum monochromatic radiation. In general, the x irradiation produced an exponential attenuation in the ratio of the irradiated to the non-irradiated intensity, but anomalies in the reflections from certain crystallographic planes indicated the presence of anisotropy of the atomic displacements in the lattice of the irradiated metals. The change produced in the integral intensity of the x-ray reflections on going from liquid-nitrogen temperature to room temperature was the same for irradiated and non-irradiated samples. This indicated that the change in the integral intensity of the x-ray reflections of the investigated metals after irradiation is due to the presence of static displacements of the atoms from the lattice sites, the magnitude of these displacements being noticeably dependent on the crystallographic direction. (ATD)

16229 EFFECT OF GAMMA IRRADIATION ON THE NONELASTIC PROPERTIES OF COPPER SINGLE CRYSTALS. P. L. Gruzin, Yu. D. Zharov, and Yu. A. Polikarpov. Dokl. Akad. Nauk SSSR, 159: 1027-30(Dec. 11, 1964). (In Russian)

The effect of γ irradiation on the nonelastic properties of copper single crystals was investigated by the method of internal friction with specimens annealed at 800°C for 5 hr, γ irradiated with a dose of up to 10^8R, and subsequently annealed at 100°C for 5 hr, at 150°C for 6 hr, or at 200°C for 4 hr. The amplitude dependence of internal friction is shown. At amplitudes exceeding the amplitude which causes the separation of dislocations from lattice defects, the amplitude dependence of internal friction becomes irreversible. The level of internal friction with decreasing amplitude runs higher than that with increasing amplitude. The concentration of the defects which pin

dislocations slightly increased after γ irradiation, decreased after annealing at 150°C, partly because of a tenfold increase in the dislocation density, and increased again, with a simultaneous decrease in the dislocation density, after annealing at 200°C. The observed changes in internal friction after γ irradiation and annealing at 150°C agree with previously published data on the electric conductivity of quenched and deformed copper, and of ordered Cu_3Au alloy after neutron irradiation, quenching, and deformation. The irreversible nature of the amplitude dependence of internal friction also confirmed the interaction between crystal-lattice defects and dislocations. (ATD)

16230 EFFECTS OF GAMMA- AND X-RAY BACKSCATTERING ON THE SURFACE PROPERTIES OF SOLIDS. K. Odan and M. Kato. Genshiryoku Kogyo, 8: No. 10, 22-7(1962). (In Japanese)

The effects of different thicknesses of mortar, plywood, low-carbon steel, lead, and paraffin were studied by ^{137}Cs (100 μC) gamma- and 60- to 70-kv x-ray backscattering. Attenuation of both intensity and energy depended on the elements in the layer. Elements of atomic number 40 showed maximum intensity of backscattering. The distribution of the energy spectrum of the scattered x rays is considered to show the cause of the x ray attenuation. Absorption values for different substances were determined to show the energy spectrum of the scattered radiation. Angular distribution of the backscattered x rays was also determined. (IIC-MG)

16231 EFFECTS OF ELECTRON RADIATION ON Ge. M. Ado, F. Fidimura, and M. Oishchi. Genshiryoku Kogyo, (In No. 3, 26-31(1964). (In Japanese)

Changes in Ge electroconductivity resulting from electron irradiation varied greatly with the type of Ge, irradiation temperature, and electron energy. Monocrystals irradiated with 1-Mev electrons showed three energy levels: electron capture energy 0.062–0.12 ev, electron vacancy energy 0.073 ev, and acceptor energy 0.28 ev. Large dislocations of crystal lattice defects were related to thermal recovery. A macroscopic trend in such dislocations that occurred with local irradiation is explained by the more rapid change despite the recovery of effects of local and continuous irradiation; increase in the displacement rate with approach to the limit of local irradiation; symmetrical change in irradiated and nonirradiated parts with increasing total dose; and the fact that polarity of the applied potential may cause a symmetrical change in irradiated and nonirradiated samples. This indicates that local irradiation may cause defects in the Ge lattice parts. Thermal annealing may cause extension of defects to the nonirradiated parts, depending on the concentration of defects. It was concluded that defects of several millimeters show a greater dislocation. The addition of an electric field may displace defects as a function of the place of the energy level of the structure in the sample. (IIC-M.G.)

16232 ELECTRON PARAMAGNETIC RESONANCE IN IRRADIATED OXYGEN-DOPED GERMANIUM. John A. Baldwin, Jr. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 36: 793-5(Mar. 1965).

Electron paramagnetic resonance studies were performed in oxygen-doped germanium. Room-temperature irradiation with 2-Mev electrons produces a paramagnetic center $S = \frac{1}{2}$, the g tensor of which has $(0\bar{1}1)$, (011), (100) principal axes. The g shifts are consistent with this being the germanium A center— an oxygen-vacancy complex. Infrared absorption bands at 766, 807, and 847 cm^{-1} may be associated with this defect. (auth)

16233 ENERGY DISTRIBUTION OF ENERGETIC ATOMS IN AN IRRADIATED MEDIUM. M. D. Kostin (Princeton Univ., N. J.). J. Appl. Phys., 36: 850-1(Mar. 1965).

A set of coupled linear integral equations for the energy distributions of rapidly moving atoms in an irradiated medium composed of many species is investigated. It is assumed that only binary collisions occur in which an energetic atom interacts with a thermal atom. Solutions are obtained for the case of two species where scattering is isotropic in the center of mass system and all collision cross sections have the same energy dependence. When the mass m_1 of species 1 is much less than m_2 the collision densities have the form $f(E) = aE^{-2} + bE^{-2+4(c_1+c_2)m_1/m_2}$, where c_1 and c_2 are related to the collision cross sections. When $m_1 = m_2$, then $f(E) = aE^{-2} + bE^{-1/(1+c_1)-1/(1+c_2)}$. Similar solutions are found for intermediate mass ratios. (auth)

16234 SEMICONDUCTING DIAMONDS BY ION BOMBARDMENT. R. H. Wentorf, Jr., and K. A. Darrow (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 137: A1614-16(Mar. 1, 1965).

Both natural and synthetic diamond crystals acquire altered surface layers as the result of ionic bombardment in a glow discharge at potentials of 1500 to 2800 v. The surface layers have a gray-brown color, and electron diffraction patterns of them indicate that they are somewhat amorphous. The surface layers are found to be electrical semiconductors. The kinds of gas ions used for bombardment apparently determine whether the conductivity is predominantly n type or p type. The activation energies for conduction range between 0.024 and 0.20 ev. The surface layers are partly destroyed by heating in air to about 400°C. (auth)

16235 LOW-TEMPERATURE RECOVERY IN IRRADIATED COPPER. J. W. Corbett (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 137: A1806-8(Mar. 15, 1965).

The suggestion that I_D recovery in copper is due to a superposition of unresolved close-pair processes, instead of being due to the correlated recovery of the freely migrating interstitial as Corbett, Smith, and Walker had argued, is considered. It is shown that the initial portion of the I_D recovery in 1.4-Mev electron damage is proportional to the square root of the recovery time, precisely as required by correlated recovery. The $\sqrt{t}$ dependence is exploited to show that the initial I_D recovery exhibits an activation energy of ≈ 0.12 ev, as does the rest of I_D and I_E recovery. Thus all I_D and I_E recovery is described by the motion of one type of defect and there is no need to invoke unresolved close-pair processes. It is suggested that the fine structure observed in I_D recovery in deuteron-irradiation experiments may be due to the influence of the correlation between Frenkel pairs upon the kinetics of the recovery. (auth)

16236 PRODUCTION OF DEFECTS IN InSb BY X RAYS. George W. Arnold and Frederick L. Vook (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 137: A1839-42 (Mar. 15, 1965).

Changes in the low-temperature electric and thermal resistance of InSb were measured at liquid-nitrogen and liquid-helium temperatures as a function of x irradiation (100 kv peak, 12 mA, W target). The direction and asymptotic behavior of the changes on x irradiation are analogous to those produced by fast-electron irradiation and indicate bulk damage. X irradiation of originally p-type InSb produces the same changes as x irradiation of InSb that has been converted to p type by electron bombardment. The changes are not due to surface effects, since any surface changes due to ionization would have been saturated by prior electron irradiation. The photoelectrons produced by the soft x rays have energies much lower than the threshold displacement energies for a direct collision process and indicate that displacements are produced by an ionization process which may be similar to the Varley mechanism for ionic crystals. Annealing measurements of the x-ray-induced damage show that the damage almost completely anneals near 102°K. (auth)

16237 BEHAVIOR OF N-TYPE Ge EXPOSED TO HIGHLY ENERGETIC RADIATION. E. G. Wikner (General Dynamics Corp., General Atomic Div., San Diego, Calif.). Phys. Rev., 138: A294-?(Apr. 5, 1965).

Measurements of the irradiation response and subsequent recovery during annealing of the conductivity, Hall coeffi-

cient, and Hall mobility of n-type germanium are presented. The samples were bombarded at 80°K with 5- to 45-Mev electrons and with high-energy gamma rays, which produce significant amounts of damage via photoneutron reactions. The electron bombardment rate apparently had no effect on the initial irradiation response. However, Cu impurities were found to produce strong effects in both the irradiation and annealing behavior. A significant amount of annealing was observed between 80 and 300°K, which is evidently a manifestation of the defects formed by highly energetic radiation. Between 300 and 400°K impurities play an important role in the annealing, since the annealing appears to be controlled by the original chemical donor. An interpretation of the results based on a model involving migration of only a single defect is found to be inadequate. (auth)

16238 LASER EFFECT IN INDIUM ARSENIDE BY ELECTRON BOMBARDMENT. C. Benoit a la Guillaume and J. M. Debever (Universite, Paris). Solid State Commun., 2: 145-7(May 1964). (In French)

The recombination radiation from an InAs sample was observed under bombardment by 20-kev electrons in short pulses. Above a current of 300 μa in the beam, laser action was obtained. (auth)

16239 CHANGES IN THE PROPERTIES OF SURFACE LAYERS OF n-GERMANIUM RESULTING FROM BOMBARDMENT WITH 40-kev NITROGEN IONS. E. I. Zorin, D. I. Tetel'baum, Yu. S. Popov, and Z. K. Granitsyna (Gorkii State Univ., USSR). Soviet Phys.-Solid State (English Transl.), 6: 1592-5(Jan. 1965). Translated from Fiz. Tverd. Tela, 6: 2017-21(July 1964).

The variation of the electric properties of the surface layer in germanium irradiated with 40-kev nitrogen ions in doses varying from 10^{-2} to 10^{4} μC/cm^2 was investigated. It was found that the change in the electric properties with increasing radiation doses is not monotonic. A qualitative explanation of the phenomena observed is presented from the viewpoint of the modern concepts of radiation effects in semiconductors. (auth)

16240 EFFECT OF LITHIUM ON RECOMBINATION IN n-TYPE SILICON IRRADIATED BY FAST ELECTRONS. V. S. Vavilov, I. V. Kryukova, and M. V. Chukichev (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 2097-2100(Mar. 1965). Translated from Fiz. Tverd. Tela, 6: 2634-7(Sept. 1964).

The presence of a mobile impurity (lithium) and the interaction of this impurity with radiation defects in silicon led to a substantial decrease in the effect of radiation on the rate of recombination of excess carriers. The rate of bulk recombination of excess carriers was determined by measuring the short-circuit current resulting from bulk excitation by fast electrons in crystals which contain p-n junctions. (auth)

16241 RECRYSTALLIZATION OF HIGH PURITY ALUMINIUM AFTER EXPOSITION TO α-PARTICLES AND NEUTRONS. Hartmut Mayer and Brigitte Weiss (Universitat, Vienna). Z. Metallk., 56: 104-9(1965). (In German)

Recrystallization of high purity aluminium (99.99 wt %) was investigated by microscopy, microhardness, and electrical resistivity. The effect of α particles and neutrons on recrystallization was observed. Irradiation did not change the recrystallized microstructure and there was no measurable effect on nucleation. Grain growth following nucleation could be influenced if the specimens were irradiated at the end of the nucleation process when visible grain growth started. A calculation indicated that grain growth in irradiated specimens can be described by the activation energy of the unirradiated condition and a second activation energy which is somewhat larger. An explanation was attempted by the assumption that the nuclei originated by polygonization. (auth)

16242 A SUMMARY OF RADIATION EFFECTS THRESHOLDS. Donald J. Hamman (Battelle Memorial Inst., Columbus, Ohio). 7p. (CONF-651-55)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The objectives and scope of the Radiation Effects Information Center are outlined. Three radiation-effects threshold graphs are presented for (1) material classes in a neutron flux, (2) polymeric materials in a gamma flux, and (3) electronic materials and devices in a neutron flux. (D.L.C.)

16243 EFFECT OF HIGH-ENERGY RADIATION ON ELECTRIC CONDUCTION OF POLYETHYLENE. M. Ieda, M. Kosaki, Y. Yamada, and U. Shinohara (Nagoya Univ., Japan). 10p. (CONF-769-8)

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

The effects of radiation on the electric resistivity of polyethylene and polypropylene were studied. Gamma rays and electrons in air and vacuum were used on various crystalline polymers, and the results were expressed in ρ-1/T graphs. At room temperature, ρ of polyethylene decreases with radiation dose. Near the melting point, this decrease nearly disappears and ρ jumps up to near the nonirradiated value. Annealing of the irradiated specimens eliminates the radiation effect, and the jumping-up phenomenon is ascribed to recombination of radioinduced charge carriers upon melting. Polypropylene does not exhibit the jumping-up phenomenon; instead, the curves for irradiated specimens gradually approach the nonirradiated curve at a temperature below the melting point. (D.L.C.)

16244 RADIATION DAMAGE IN SiC. Richard Babcock (Westinghouse Electric Corp., Pittsburgh). 18p. (CONF-792-2)

From American Ceramic Society Meeting, San Francisco, Oct. 1964.

SiC has a band gap energy of about 2.9 ev; if intrinsic SiC could be made, it would be an extremely good insulator at room temperature. In practice, the uncompensated room temperature resistivity of single crystal SiC rarely exceeds 100 Ω-cm, and it is a useful semiconductor. Studies were made on degradation of SiC p-n junctions in charged particle and neutron fluxes. Useful life was found to be 10-100 times greater than can be achieved in comparable Si devices. (P.C.H.)

METEOROLOGY

See *also* GEOLOGY AND MINERALOGY — Site Survey and Selection.

Refer also to abstracts 15762, 16747, and 16761.

16245 (RT/PROT(64)-19) II ANNUARIO METEOROLOGICO DEL CENTO DI STUDI NUCLEARI DELLA CASACCIA, 1963. (Second Annual Report on Meteorology of the Centro di Studi Nucleari of Casaccia, 1963). G. Giudici and P. Mingrone (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). Sept. 1964. 104p. Dep.(mn).

The meteorological observations made at Casaccia from Dec. 1, 1962, to Nov. 30, 1963, are reported. The topographic and climatological profiles of the region are given. Then the atmospheric phenomena observed (precipitation, air temperature, relative humidity, atmospheric pressure, sunlight, and wind) are reported tabularly and graphically. (J.S.R.)

16246 ON DETERMINING THE PLACE OF RADIOACTIVATION OF PRECIPITATION FORMS. L. Manolov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 9: 99-109(1962). (In Russian)

A critical assessment was made of the two existing views on the determination of the place of radioactivation of the various types of precipitation. The view is resolutely supported that radioactivation takes place chiefly in cloud formations and to a very small degree in the course of rainfall. This was proved in two ways: through comparing the daily values of the natural beta radioactivity of the aerosols in the layer close to the surface with the daily fluctuation of the amount of low cloudiness; and through functional relationships between average values of natural beta radioactivity of the aerosols in the presence of a given amount of low cloudiness within a certain interval of time (months, year) and the amount of low cloudiness. The accumulating effect of cloud formations is stressed. It was concluded that for the deactivation of the atmospheric layer close to the ground in the Sofia area cloudiness and winds emerge as chief deactivators while the effect of the other meteorological factors (horizontal visibility, barometric trend, precipitation forms, soil condition, etc.) is insignificant. (auth)

16247 GROSS-ATMOSPHERIC CIRCULATION AS DEDUCED FROM RADIOACTIVE TRACERS. Bert Bolin (Univ. of Stockholm). p.479-508 of "Research in Geophysics. Vol. 2." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

The use of radioactive tracer techniques for atmospheric circulation studies must be treated as a complement to ordinary meteorological studies. Theoretical expressions for transfer processes in the atmosphere are reviewed. The use of stable atmospheric tracers — CO_2, O_3, water vapor — is surveyed. The suitability of various radioactive tracers is discussed: ^{222}Rn and daughters; cosmic-ray produced activity such as ^{3}H, ^{7}Be, ^{10}Be, ^{14}C, ^{22}Na, ^{32}Si, ^{32}P, ^{33}P, ^{35}S, ^{36}Cl, ^{38}Cl; bomb-produced isotopes such as tritium, ^{14}C, ^{185}W, ^{102}Rh. Some results from tracer measurements of gross circulation in the troposphere, lower stratosphere, and upper stratosphere and mesosphere are summarized. (M.J.T.)

PHYSICS

General

Refer also to abstracts 15606, 15702, and 17253.

16248 (AD-603602) CHARGED-PARTICLE MOTION IN AN INHOMOGENEOUS MAGNETIC FIELD (thesis). Dalton N. Wirtanen (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Aug. 1964. 113p. (GSP/Phys/64-15). $4.00(CFSTI).

The theory necessary to specify a distribution function for charged particles in an inhomogeneous magnetic field was developed. A transfer function is used to define the probability that particles will go from a given state A to a state B in a characteristic distance traveled. The equations of motion for the particles have been derived in order to evaluate the moments of the transfer function. The magnetic field due to two specific magnetic traps is calculated. The first trap is formed by superimposing a transverse field, due to a number of infinite straight current carrying rods, upon a uniform axially-symmetric field. The second trap is of the same form but of finite length with axial magnetic mirrors at each end (Ioffe bottle). The motion of the charged particles in the infinite conductor configuration was numerically calculated. In the magnetic trap, there seems to be a tendency for the particles with particular injection parameters to escape radially. Other injection parameters tend to result in the containment of the particles. (auth)

16249 (AD-609177(Sec.B)) REACTION KINETICS OF THE FISSION-FRAGMENT PLASMA. (General Motors Corp., Warren, Mich. Research Labs.). 17p.

The atomic and ionic reactions in a plasma formed by fission fragments in Penning gas mixtures are analyzed. Seven equations are written for atomic and molecular ions of both major and minor species, metastable atoms of the major species, excited states other than metastable of the major species, plus charge neutrality. Approximate solutions are obtained for the major and minor gas constituent density, to give maximum electron density. The classical Penning effect — increase in ion source rate because of conversion of major species metastable atoms to minor species ions — is a relatively small advantage. Much more important is the decrease in minor species atomic ion loss rate. This rate can be drastically reduced by operating in the regime of parameters where atomic ions of the minor species must form molecular ions via 3-body collisions. This process can be made very slow. Examples are given for neon–argon gas. (auth)

16250 (AD-609177(Sect.D)) PRODUCTION, DIFFUSION AND CONVERSION RATES OF IONS, METASTABLE AND EXCITED STATES IN PENNING-TYPE NEON–ARGON PLASMAS. (General Motors Corp., Warren, Mich. Research Labs.).

A detailed study of the reaction kinetics of a fission-fragment-generated plasma requires knowledge of about 30 reaction rates if the plasma is created using a Penning-type gas mixture. These reaction rates represent such processes as diffusion, recombination, molecular-ion formation, charge exchange, volume ionization, and destruction in the gas of various ionic, excited, and metastable states. It is shown that, with few exceptions, these reaction rates are directly known, may be readily extracted from the literature, or may be estimated, for the neon–argon mixture. The notable exception for which it has not been found possible to give an estimate, is the production rate of metastable states from the dissociative recombination of a molecular ion and electron. After discussion of all the reaction rates, the data are collected in tabular form. (auth)

16251 (AFOSR-64-1647) MACROSCOPIC MAGNETO-FLUID DYNAMICS. Final Report. J. Berkowitz and Harold Grad ([Courant Inst. of Mathematical Sciences, New York Univ., N. Y.]). Sept. 1964. Contract AF49(638)-1006. 8p. (AD-605532). $1.00(CFSTI).

A program was undertaken to understand the mathematical structure and content of the basic equations of the subject, paying special attention to nonstandard mathematical problems which arise. The steady flow past a wedge was studied. The Mach cones in three dimensions were computed and found to be extremely singular. The flow past an airfoil, governed at certain intermediate speeds by a fourth order "composite" system which is partly elliptic and partly hyperbolic, was studied. An extensive existence theory of the linear Boltzmann equation was developed using estimates for the Boltzmann collision operator. Also, a detailed study of wave propagation using normal modes was made. (auth)

16252 (BNL-8888) TWO-DIMENSIONAL FIELDS AS FUNCTIONS OF A COMPLEX VARIABLE. R. A. Beth (Brookhaven National Lab., Upton, N. Y.). Feb. 9, 1965. Contract AT(30-2)-Gen-16. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The representation of two-dimensional electric or magnetic fields as functions of a complex variable is outlined. Generalized field functions are introduced, and applications are suggested, especially in finding numerical values by relaxation methods. (C.E.S.)

16253 (HW-SA-3320) ASYMPTOTIC EXPANSION OF $J_\nu(ap)\,Y_\nu(bp) - J_\nu(bp)\,Y_\nu(ap)$. Albert L. Ruiz (Hanford Atomic Products Operation, Richland, Wash.). Jan. 27, 1964. Contract AT(45-1)-1350. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Wave propagation in a hollow circular cylinder includes expressions of the form $M = J_\nu(ap)\,Y_\nu(bp) - J_\nu(bp)\,Y_\nu(ap)$ in which a = outer radius of cylinder, b = inner radius, and $\nu = c\xi$. An asymptotic expansion of M is given. (C.E.S.)

16254 (MATT-221) ON THERMODYNAMIC EQUILIBRIUM IN A GRAVITATIONAL FIELD. N. L. Balazs and J. M. Dawson (Princeton Univ., N. J. Plasma Physics Lab.). Nov. 1963. Contract AT(30-1)-1238. 22p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

Thermal equilibrium in a gravitational field is examined using the standard tools of thermodynamics but including the relativistic effects associated with the mass energy relation. It is found that an appropriately defined temperature is not constant at equilibrium but decreases with increasing gravitational potential. The gravitational red shift is a simple manifestation of this. In terms of this temperature the local thermodynamic properties are independent of the gravitational potential. It is also found possible to define another temperature which is uniform at equilibrium. However, use of this temperature requires that the thermodynamic properties (for example, melting points) be explicit functions of the gravitational potential. (auth)

16255 (ML-1146) MODE COUPLING IN BOUNDED, COLD BEAM-PLASMA SYSTEMS. Final Report. J. C. Eidson (Microwave Lab., Stanford Univ., Calif.). Aug. 1964. Contract AF30(602-3098. 152p. (AD-605265; RADC-TDR-64-189). $5.00(CFSTI).

The study is concerned with the problem of guided wave propagation and electron beam interaction in bounded systems containing a plasma. The model used in the study is a circular conducting guide partially filled with a uniform, stationary, zero-temperature plasma contained with a finite axial d-c magnetic field. For the electron beam interaction study the beam is assumed to be of uniform cross section and perfectly neutralized. The modes in such a system are studied. A detailed treatment using the quasi-static assumption is given. A second study of the modes includes the effects of divergence-free fields, which are neglected in the quasi-static approximation. The interaction of a neutralized electron beam with the modes in the finite

plasma system is investigated by means of normal mode and variational techniques. The results of an experiment using a thermal cesium plasma, which qualitatively verify the mode splitting and deformation predicted by the coupled-mode theory are presented. (auth)

16256 (MLM-1163(p.A-1-14)) THE THEORY AND OPERATION OF A DEVICE FOR THE MEASUREMENT OF THE COEFFICIENT OF THERMAL DIFFUSION IN GASES. W. L. Taylor (Mound Lab., Miamisburg, Ohio).

The theory of thermal diffusion is developed using rigorous kinetic theory. A device for determining accurately the thermal diffusion factor a in binary systems and called the Trennschaukel or "swing separator," is described. The limitations on the device are discussed, and various correction terms are given. (D.L.C.)

16257 (MLM-1163(p.C-1-7)) THERMAL DIFFUSION IN LIQUIDS. W. M. Rutherford (Mound Lab., Miamisburg, Ohio).

The relationships between diffusion and heat conduction are discussed. A formal treatment of thermal diffusion by methods of steady-state thermodynamics is presented. The determination of q_1^* (heat of transport) using kinetic theories is considered. The resulting equation for the thermal diffusion factor is applied to the methane–n-butane system over the critical and liquid regions of the phase diagram; agreement with experimental data is quite good. (D.L.C.)

16258 (SC-RR-64-1756) SOUND RAYS IN THE ATMOSPHERE. R. J. Thompson (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract AT(39-1)-789. 12p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

A system of ordinary differential equations governing ray paths in the presence of winds is derived and discussed. The equations are derived under the assumption that the winds and the speed of sound depend only on altitude. The results are compared with several methods that have been used for finding ray paths approximately. (auth)

16259 (TID-21380) QUARTERLY PROGRESS REPORT NO. 75. H. J. Zimmermann and G. G. Harvey (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Oct. 15, 1964. Contract AT(30-1)-1842. 240p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Research and Development is reported in sections on geophysics, plasma physics, plasma electronics, and plasma magnetohydrodynamics and energy conversion. Separate abstracts were prepared for these sections. Other sections included in the report for which no abstracts were prepared are concerned with aspects of radio physics, and communications sciences and engineering. (J.R.D.)

For abstracts of individual sections see: 16448, 17078, 17079, and 17080.

16260 (UCRL-7980-T) THE PROPAGATION OF SHOCKS IN EXPONENTIALLY DECREASING ATMOSPHERES. R. Grover and J. W. Hardy (Lawrence Radiation Lab., Univ. of California, Livermore). [196?]. Contract W-7405-eng-48. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An exposition is presented of a similarity solution to the hydrodynamic equations in planar symmetry. The solution describes an explosion in an exponentially decreasing atmosphere. Comparisons are made between the properties of this solution and those of a calculated explosion. The similarity solution was actually suggested by an examination of the asymptotic behavior of a calculated explosion, and agrees excellently with it. A number of numerical results pertinent to these solutions are presented. Stability of the asymptotic behavior of the explosion to boundary conditions (structure of the source) is presented, both through examination of similarity solutions and the explosion calculations for different types of sources. The asymptotic behavior of the shock wave is found to be virtually independent of the source for a large class of them. A comparison of the results for shock acceleration to those predicted by Chisnell is given. Also presented are numerical results for explosions in cylindrical and spherical symmetries. Comments are given concerning the convergence of these solutions to those of planar symmetry. (auth)

16261 (UCRL-11606) SURFACE IONIZATION OF Na, Rb, LiI, AND NaI ON TUNGSTEN, RHENIUM, AND PLATINUM–TUNGSTEN. Kent R. Wilson and Richard J. Ivanetich (Lawrence Radiation Lab., Univ. of California, Berkeley and California Univ., Berkeley. Dept. of Chemistry). Aug. 25, 1964. Contract W-7405-eng-48. 28p. Dep.; $2.00(cy), 1(mn) CFSTI.

The ionization of Na, Rb, LiI, and NaI was measured on tungsten, rhenium, and 92% platinum–8% tungsten surfaces as a function of surface temperature. The results are compared with the predictions of the Saha-Langmuir equation, and deviations are discussed. The technique of differential surface ionization is shown to distinguish between Li and LiI and between Na and NaI. The role of surface contamination is discussed. Rhenium is shown to give more efficient surface ionization than tungsten for Na, NaI, and LiI. (auth)

16262 (UCRL-12158) THE GREEN'S FUNCTION FORMALISM FOR MULTICOMPONENT SYSTEMS. J. C. Garrison (Lawrence Radiation Lab., Univ. of California, Livermore). Nov. 13, 1964. Contract W-7405-eng-48. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The principal results of the thermodynamic Green's function formulation of quantum statistical mechanics are written in a form suitable for application to systems containing several species of particles. Various useful quantities such as the single-particle self-energies, the vertex functions, the dressed interactions, and the Schwinger interaction operator are defined in the context of a multicomponent system. As a special case, systems of charged particles are treated in somewhat more detail. (auth)

16263 (USCEC-82-212) DYADIC GREEN'S FUNCTION FOR A RADIALLY INHOMOGENEOUS SPHERICAL MEDIUM. Cavour W. H. Yeh (University of Southern California, Los Angeles. Engineering Center). May 1963. Contract AF19(604)-6195. 12p. (EE-28; AFCRL-63-345; AD-422596). $1.60(CFSTI).

The general expression for the dyadic Green's function in a radially inhomogeneous dielectric medium is obtained. It is then applied to the problem of radiation from an electric dipole in such a medium. Possible applications to electromagnetic scattering problems and to elementary particle scattering problems are noted. (auth)

16264 (LA-tr-65-4) TRANSFER PHENOMENA IN COMPRESSED GASES. I. DETERMINATION OF THE HEAT CONDUCTIVITY COEFFICIENTS OF COMPRESSED GASES (H_2, N_2, Air, CH_4, AND CO_2). E. A. Stoliarov, V. V. Iparov, and V. P. Teodorovich. Translated by Helen Chick (Los Alamos Scientific Lab., N. Mex.), from Zh. Fiz. Khim, 24: 161-76(1950). 22p. Dep.(mn); $1.00(cy), 1(mn); CFSTI; $2.60(fs), $0.86(mf) JCL.

Thermal conductivity coefficients were measured with an accuracy of 3% using Schleiermacher's method, for the gases H_2, N_2, air, CH_4, and CO_2 at 0 to 300°C and 1 to 500 kg/cm². It is shown that near the critical temperature, the thermal conductivity mechanism changes to one similar to that of liquids. The effects of pressure on the thermal conductivity is discussed. (D.L.C.)

16265 ON A RADIATION OF A CHARGE IN INHOMOGENEOUS MEDIUM. B. V. Khachatryan and S. S. Elbakyan (Erevan State Univ. and Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 17: No. 5, 127-9(1964). (In Russian)

Previously derived formulas for the energy emission by electrons uniformly moving across inhomogeneous media and for energy emission at angle α to the inhomogeneous media were correlated, and incongruencies in these formulas were analyzed. (R.V.J.)

16266 PREPARATION OF THIN TARGETS FOR CHARGED-PARTICLE WORK. Yu. A. Selitskii and S. M. Solovev. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1724(Oct. 1964). (In Russian)

A simplified method of preparing thin 2 × 2 cm targets with a substrate thickness varying from 4×10^{-5} to 10^{-3} gr/cm^2 and an active-area thickness of up to 3×10^{-4} gr/cm^2 for experimental research on charged particles is described. Targets were prepared by evaporating aluminum or silver and either uranium or thorium tetrafluoride on a glass plate covered with a thin layer of liquid soap. To separate the target, the glass plate was immersed in water at an angle. A frame with a round opening was then brought into contact with the target which, when positioned to cover the hole, clung to the frame without the use of an adhesive. It was found that targets prepared in this manner can withstand a deuteron flow of 0.5 μamp for several hours. (ATD)

16267 LINE POSITIONS AND QUADRUPOLE COUPLING IN MÖSSBAUER IRON EXPERIMENTS. P. H. Remy and H. Pollak (Lovanium Univ., Leopoldville, Congo). J. Appl. Phys., 36: 860-1(Mar. 1965).

By analysis of published data, a linear relation between the isomeric shift and the quadrupole coupling in four classes of iron compound was obtained, together with equations for the two Mössbauer peak positions. The relations were used to determine the sign of the electric field gradient and to predict the position of the second peak of a doublet for which the position of one peak was known. (D.C.W.)

16268 DYNAMICS OF A SIMPLE MANY-BODY SYSTEM OF HARD RODS. D. W. Jepsen (International Business Machines Corp., Yorktown Heights, N. Y.). J. Math. Phys. (N. Y.), 6: 405-13(Mar. 1965).

General formulas are given for the exact calculation of the nonequilibrium properties of the one-dimensional system of equal-mass hard rods both for finite but large system and in the limit of infinite size. Only properties which depend upon labeling one or more of the particles are nontrivial in this system. Various results are obtained on Poincaré cycles, delocalization of a particle with time and electrical conductivity when one particle is charged. (auth)

16269 SELF-CONSISTENT APPROXIMATIONS IN MANY-BODY SYSTEMS. Michael Revzen (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 6: 450-3(Mar. 1965).

Baym's definition of a self-consistent approximation is rephrased in a more diagrammatic way and compared with formulations of the exact many-body problem of Balian, Bloch, and DeDominicis. It is shown that many of the results of these authors are valid for any self-consistent approximation as defined by Baym. (auth)

16270 THE RANGE OF APPLICABILITY OF PERFECT FLUID MAGNETOHYDRODYNAMICS TO A MAGNETIC CHANNEL FLOW. Masayoshi Tajiri (Osaka Prefecture Univ.). Kakuyugo-Kenkyu, 12: 24-34(Jan. 1964). (In Japanese)

The range of applicability of perfect-fluid magnetohydrodynamics to a magnetic channel flow is studied numerically. A brief discussion of the magnetic channel flow is also given. (auth)

16271 THE MAGNETIC POTENTIAL OF AXIALLY SYMMETRIC FIELDS. G. Bosi (Universita, Rome). Nucl. Instr. Methods, 33: 68-70(Mar. 1, 1965).

A general expression for the magnetic potential of axially symmetric fields is carried out: the results are rigorously correct, if no currents are present. The problem is solved by a harmonical function, whose axial derivative fits the given field form in the median plane: this coincidence is imposed up to second order terms. The given solution succeeds in the range $0 < r < 2r_0$, r being the distance from the symmetry axis and r_0 the central orbit radius. Formulas are checked by comparison with an analytical method proposed by Gersch, which yields approximate results. (auth)

16272 ON THE RELATIVISTIC PROBLEM OF LEVER ARMS. H. Arzelies (Faculte des Sciences, Bordeaux and Faculte des Sciences, Rabat). Nuovo Cimento (10), 35: 783-91(Feb. 1, 1965). (In French)

It is shown that this problem has until now been treated in an incorrect manner; it is necessary to abandon the interpretation with transverse impulse and energy flux. The rejection of these concepts modifies the equations for the relativistic dynamics of continuous media. (tr-auth)

16273 RELATIVISTIC TRANSFORMATION OF THE TEMPERATURE AND SOME OTHER THERMODYNAMIC PARAMETERS. H. Arzelies (Faculte des Sciences, Bordeaux and Faculte des Sciences, Rabat). Nuovo Cimento (10), 35: 792-804(Feb. 1, 1965).

It is shown that the usual equations of relativistic thermodynamics are incorrect; the correct relations are derived. Particularly, it is shown that the temperature should transform according to $T = T_0/\sqrt{1-\beta^2}$, not $T = T_0\sqrt{1-\beta^2}$. (D.C.W.)

16274 A NEW METHOD OF EXPANSION IN MATHEMATICAL PHYSICS. PART I. G. Sandri (Aeronautical Research Associates of Princeton, Inc., Princeton, N. J.). Nuovo Cimento (10), 36: 67-93(Mar. 1, 1965).

The general method for uniformizing perturbation expansions which we have introduced recently (method of "extension") is further developed. The presentation given is self-contained and does not rely on explicit use of composition of mappings. The compatibility conditions that the method gives rise to are discussed and so is the basic induction theorem. A new very general uniformizing formula is derived. The Poincaré-Lighthill procedure is deduced from this formula in a simple fashion. A general theory for the Fourier transforms of extended functions is developed. (auth)

16275 DETERMINATION OF SPECTRAL PROFILES FROM CORRELATION MEASUREMENTS. C. L. Mehta (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 36: 202-5(Mar. 1, 1965).

From correlation measurements one can determine the modulus $|\gamma(\tau)|$ (for real τ) of the coherence function which is the Fourier transform of the spectral density. It is shown that by using exponential filters one can determine $|\gamma(\tau)|$ for complex τ also. From these measurements and using analytic properties of $\gamma(\tau)$, one can determine $\gamma(\tau)$ (i.e., its phase also) and hence the spectral density. (auth)

16276 KINETIC EQUATION FOR A DILUTE GAS WITH SHORT-RANGE FORCES. S. Harris and M. B. Lewis (Northwestern Univ., Evanston, Ill.). Phys. Rev., 137: A1392-1400(Mar. 1, 1965).

The kinetic equation for a dilute gas with short-range forces is derived by a method which is believed to be physically more transparent than other methods. A density expansion is first derived for the correlation functions, the coefficients of which are functionals of F_1, the first distribution function. These functionals relax to time-independent functionals over a time interval τ (which is considered to be of the order of the duration of a collision) after a time τ_0 (which is characterized by the phases) from the initial time. The functionals contain F_1 over the interval τ and therefore the resulting kinetic equation is non-Markoffian. The non-Markoffian behavior is removed by further expanding the correlation functions in a parameter that is the ratio of the duration of a collision to the mean free time. The results for the correlation functions are carried to first order and agree with those of other methods for configurations in which the particles are interacting, and therefore lead to the same kinetic equation, but are otherwise different. (auth)

16277 COLLECTIVE EXCITATIONS IN SPIN-DENSITY-WAVE SYSTEMS. A. K. Rajagopal (Harvard Univ., Cambridge, Mass.). Phys. Rev., 137: A1429-32(Mar. 1, 1965).

The collective excitations of systems which have Overhauser spin-density-wave ground states are investigated using a Bogolyubov transformation and the random-phase

approximation. It is found that there may be transverse oscillations of the antiferromagnetic spin-wave character as well as longitudinal oscillations of the plasma type. The calculations are based on a short-range model. (auth)

16278 OPTICAL EMISSION STUDIES OF THE CHARACTERISTIC ENERGY LOSSES IN Cd, In, AND Zn. R. J. Herickhoff, E. T. Arakawa, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A1433-5(Mar. 1, 1965). (ORNL-P-572)

Recent investigations of light emission from electron-bombarded Al and Mg foils yielded results in good agreement with the theory of plasma oscillations in metals and the electron energy-loss experiments. Since the optical method is a more accurate means of measuring the plasma frequency and studying the characteristic energy losses than the electron energy loss method, optical emission studies were continued by bombarding Cd, In, and Zn foils of 600 to 1000 Å in thickness with 60- to 100-kev electrons and analyzing the light emitted at 30° from the foil normal with a Seya-Namioka vacuum ultraviolet spectrometer. A sharp, intense peak with a half-width of 0.9 ev was observed in Cd at 9.1 ev, and a less intense peak was observed in In at 11.8 ev, whereas in Zn only an edge at 8.6 ev beyond which the intensity dropped sharply was observed. These values correspond quite well with soft x-ray energy levels. Thus the emissions are due either to interband transitions or to plasma decay. Using known optical constants, the theoretical transition radiation spectrum was calculated for In and showed good agreement with the experimental line shape. (auth)

16279 THERMAL PROPERTIES OF THE INHOMOGENEOUS ELECTRON GAS. N. David Mermin (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: A1441-3 (Mar. 1, 1965).

A variational property of the ground-state energy of an electron gas in an external potential $v(r)$, derived by Hohenberg and Kohn, is extended to nonzero temperatures. It is first shown that, in the grand canonical ensemble at a given temperature and chemical potential, no two $v(r)$ lead to the same equilibrium density. This fact enables one to define a functional of the density $F[n(r)]$ independent of $v(r)$, such that the quantity $\Omega = \int v(r)n(r)dr + F[n(r)]$ is at a minimum and equal to the grand potential when $n(r)$ is the equilibrium density in the grand ensemble in the presence of $v(r)$. (auth)

16280 THEORY OF THE IONIZATION OF GASES BY LASER BEAMS. B. A. Tozer (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Phys. Rev., 137: A1665-7(Mar. 15, 1965).

The ionization of gases by intense pulsed laser beams is discussed. In particular, the production of ions and electrons by direct multiple absorption of photons is considered in simple terms, and it is concluded that the experimentally observed gas breakdown is probably initiated by this process, but that the subsequent growth of electron population is governed by some other process, such as inverse bremsstrahlung, or the acceleration of electrons in the oscillatory field. The theory predicts that the variation of threshold photon intensity for breakdown of a gas should exhibit almost pressure-independent low and high limits, that the range of intensities between these limits should be approximately $(10^{13})^{1/N_p}$, where N_p is the number of photons required to raise the atom to its lowest excited state, and that the threshold flux density will vary with change of focal volume as V^{-1/N_p}. (auth)

16281 ELECTRICAL BREAKDOWN OF GASES AT ELEVATED TEMPERATURES. A. N. Kontaratos and S. T. Demetriades (STD Research Corp., Pasadena, Calif.). Phys. Rev., 137: A1685-6(Mar. 15, 1965).

A recently developed analytical expression relating α/p with E/p (α is the Townsend ionization coefficient, E the applied field strength, p the pressure) is used in conjunction with an appropriate breakdown criterion to theoretically formulate the experimental Paschen's law. Variations of both temperature and pressure are considered in this derivation. Theoretical and experimental values of both αd (d is the length of the discharge gap) and the minimum breakdown voltage for air are in close agreement in the region of validity of the streamer theory, i.e., for pd > 500 mm Hg × cm. (auth)

16282 QUANTUM DENSITY OSCILLATIONS IN AN INHOMOGENEOUS ELECTRON GAS. W. Kohn and L. J. Sham (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: A1697-1705(Mar. 15, 1965).

An infinite system of electrons in its ground state, subject to a very slowly varying external potential, has slowly varying properties, and can be described by a gradient expansion theory. However, when, in addition, either there is a spatially rapidly varying perturbing potential, or there are regions in which the electron density drops to zero (e.g., electrons in an oscillator potential), the density and other properties of the system exhibit additional spatial oscillations, called quantum oscillations. An example is the Friedel oscillations in metals. A general theory of these oscillations for one-dimensional, noninteracting electrons is developed. Illustrations are worked out which show that when the quantum oscillations are superposed on the smooth semiclassical results, one can obtain very accurate approximations to the exact densities. (auth)

16283 GOLDSTONE THEOREM IN NONRELATIVISTIC THEORIES. R. V. Lange (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Oxford Univ.). Phys. Rev. Letters, 14: 3-6(Jan. 4, 1965).

A theorem by Goldstone, in its nonrelativistic form, seems to show that a many-particle system such as a superconductor, condensed Bose gas, or ferromagnet, with a ground state of lower symmetry than the Hamiltonian, must have an excitation mode with energy tending to zero for long wavelength. It is shown that the theorem is irrelevant in nonrelativistic theories. Specifically, it is concluded that the theorem fails to determine that the energy of an excitation branch tends to zero for infinite wavelength, because of the nature of macroscopic conservation laws and related surface integrals when finite-energy, long-wavelength modes exist. (D.C.W.)

16284 MAGNETIC RELAXATION AND ASYMMETRIC QUADRUPOLE DOUBLETS IN THE MÖSSBAUER EFFECT. M. Blume (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 96-8(Jan. 25, 1965). (BNL-8722)

It is shown that the asymmetry of quadrupole lines in Mössbauer spectra from isotropic polycrystalline sources can arise as a result of the fluctuating electric and magnetic fields produced by the relaxation of paramagnetic ions or by fluctuation of the environment surrounding the nucleus. (D.C.W.)

16285 LEAKY SPACE-CHARGE WAVES I: ČERENKOV RADIATION. I. Palocz and A. A. Oliner (IBM Research Center, Yorktown Heights, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.). 53: 24-36(Jan. 1965).

A theoretical approach is presented for the analysis of the Cherenkov effect. The radiation is associated with the presence of leaky space-charge waves on a modulated electron beam. The new theory, which is rigorous within the customary linearized regime, takes into account the effect of finite beam thickness and the actual space-charge waves on the beam. Of greater significance is the fact that it permits a self-consistent type of description, i.e., it includes the influence of the radiation back on the beam. A linear perturbation calculation is also employed to obtain useful expressions in simple but accurate form. This leaky wave approach not only rapidly reproduces the known results relating to Cherenkov radiation, but offers some new information as well. Among other results, it is found that there exists an optimum beam thickness and velocity, and that a discrete infinite set of leaky space-charge waves occur so that the radiation does not emerge ideally at a single angle, although the angular spread is found to be very small. Interesting differences arise between the fast and slow space-charge waves; the fast waves decay along the beam while the slow waves are growing waves. The tranverse field dependences of these two wave types are also different. Nu-

merical results are presented for certain typical parameter values. (auth)

16286 A TRAJECTORY EQUATION FOR CHARGED PARTICLES AND SOME APPLICATIONS. S. V. Yadavalli (Stanford Research Inst., Menlo Park, Calif.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 84-5(Jan. 1965).

Equations for the trajectories of charged particles are derived to provide an estimate of space-charge effects on such things as the characteristics of a bending magnet used for high-current beams. (R.E.U.)

16287 RUTHERFORD MEMORIAL LECTURE, 1963. THE INDUSTRIAL DEVELOPMENT OF NUCLEAR POWER. T. E. Allibone. Proc. Roy. Soc. (London), Ser. A, 282: 447-63(Dec. 8, 1964).

A review is given of developments in nuclear physics and subsequent reactor applications from the time of Rutherford to the present. (R.E.U.)

16288 ON A STATISTICAL THEORY OF SPIN RELAXATION. Huzio Nakano and Akio Yoshimori (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 685-702(Nov. 1964).

A new stochastic-theoretical treatment of the spin relaxation phenomena is proposed, the effect of the heat bath being taken into account in the theory. It is based on a rate equation of the spin system in contact with the heat bath, where one can determine the transition probability θ per unit time. The rate equation substituted with well determined θ is reduced to a Fokker-Planck equation, which involves the effect of the temperature. The stochastic process of spin motion is determined by this equation. In the case of high temperature or low static field and of small deviation from the thermal equilibrium one can obtain the Bloch equation. The method can be applied also to the treatment of the relaxation of quantum mechanical spin motion recently investigated by Korringa and Yoshimori. (auth)

16289 CASCADE IONIZATION OF A MEDIUM UNDER THE ACTION OF AN INTENSE LIGHT FLASH. G. A. Askaryan and M. S. Rabinovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 290-4(Jan. 1965). (In Russian)

Cascade growth of the ionization in a medium caused by a strong light flash is considered. It is shown that decomposition of excited atoms under the action of the light field may play an important role in the development of the electron cascade. Diamagnetic disturbances produced by light focused on a medium in an external magnetic field are considered. The dependence of induction signals from these disturbances as a function of conductivity, size, and velocity of the hot zone is presented. The results can be used for estimating the interaction force between the heated zone and magnetic field; this force may be used for driving a plasma out of an inhomogeneous field, for acceleration of a plasma, filling of traps etc. (auth)

16290 INVESTIGATION OF THE EFFECT OF PRESSURE ON THE PROCESS OF CONDUCTIVITY RISE OF SPARKS IN VARIOUS GASES. G. A. Vorob'ev, A. I. Golynskii, and G. A. Mesyats. Zh. Tekhn. Fiz., 34: 2153-5(Dec. 1964). (In Russian)

Experimental data are given on the effect of pressure on the spark-conductivity characteristics in air, hydrogen, nitrogen, carbon dioxide, helium, and freon. The gases investigated were 99.8 percent pure. Nitrogen and carbon dioxide were dehumidified by channeling them through a coil pipe cooled by liquid nitrogen. The inductance of the discharge circuit was about 10^{-9} H and the time constant 1.3×10^{-11} sec. The discharge current reached 100 amp. The pulse frequency was 0.1 cps. The oscillograms of the pulse fronts as functions of time are presented for each gas at various pressures. A section of fast rise followed by a portion of much slower increase are general characteristics of these fronts for air, nitrogen, carbon dioxide, and freon. Carbon dioxide has two steps at pressures below 0.5 atm. For freon at pressures below 3 atm, a constant shift of the curve occurs with the change of pressure. Hydrogen, distinctively, displays no steps, but has a rather slow-starting rise which steepens smoothly with time. Conductivity as a function of pressure was plotted on the basis of the aforementioned oscillograms. These curves display a characteristic discontinuity at a certain pressure for each gas. Beyond that pressure, the dependence, in logarithmic scale, approximates straight lines for all gases except freon, for which no continuation of the curve beyond the critical pressure was obtained in the experiments described. (ATD)

16291 MAGNETOHYDRODYNAMIC COUETTE FLOW. L. A. Vulis and K. E. Dzhaugashtin. Zh. Tekhn. Fiz., 34: 2171-7(Dec. 1964). (In Russian)

It is noted that in earlier studies of hypersonic Couette flow, although there were obtained by numerical methods characteristic hysteretic field dependences of the friction and heat transfer, there was no consistent attempt made to interpret the results from the physical standpoint, in particular the existence of critical transitions, etc. There are deduced in reasonably straightforward fashion analytic expressions for Couette flow for a conducting gas, taking into account nonlinear temperature dependence of the electric conductivity. These allow interpreting some of the characteristics of this complex phenomenon, and bringing out the effect of some factors ignored in earlier studies. The difference in this approach is that the usual initial set of differential equations is replaced by a system of transcendental algebraic equations by a single transformation. This also takes care of the boundary conditions, for the basic parameter—the distance between the parallel plates—is brought in from the start, in the form of a ratio to replace the differential operators. General solution of the nonlinear problem allows of distinguishing two characteristic regions (a hysteretic and a noncritical) and of determining with some approximation the critical conditions for transition from one steady state to the other. Thereafter for one of the steady states one can make use of the complete solution of the system for the case of constant conductivity. Analysis of the different factors with the aid of the deduced equations leads to results consistent with those of Bush as regards variation of the friction and heat transfer in a boundary layer. (ATD)

16292 EXCITATION OF A PLANE SEMI-INFINITE WAVEGUIDE BY A STEADILY MOVING CHARGED FILAMENT. Yu. M. Aivazyan. Zh. Tekhn. Fiz., 34: 2192-4 (Dec. 1964). (In Russian)

The problem of excitation of two parallel, semi-infinite, ideally conducting semi-planes by a steadily moving charged filament is solved by reducing it to solution of a set of two functional equations or a system of conjugate integral equation, which can be solved exactly by the Weiner-Hopf method. The filament with linear charge density ρ moves at a constant velocity v past the two parallel semi-planes ($y = \pm b$, $x < 0$) without intersecting them and at a distance a from the origin. The fields E and H are expressed in terms of the Hertz vector Π in the usual way and then Π is sought in the form $\Pi(x,y,t) = (1/2\pi)\int\mathcal{F}(q,y,\omega)\exp(-iqx + i\omega t)dqd\omega$. The further operations are based on assumptions of continuity, vanishing of Π at infinity, and consideration of the boundary conditions. These operations finally lead to expressions for the field H_z in the waveguide and outside the waveguide. An approximate expression is adduced for H_z for large $r = x/\cos\theta$. (ATD)

16293 MÖSSBAUER EFFECT: PRINCIPLES AND APPLICATIONS. Gunther K. Wertheim. Academic Paperpacks. New York, Academic Press, 1964. 123p. $2.45.

The principles of recoilless emission and resonant absorption of gamma radiation are presented, together with a survey of the experimental applications of the Mössbauer effect. Instrumentation is also considered. (D.C.W.)

16294 ARC HEATERS AND MHD ACCELERATORS FOR AERODYNAMIC PURPOSES. PART II. Advisory Group for Aeronautical Research and Development, Paris

(France). AGARDograph 84. Sept. 1964. (CONF-752 (Pt.II))

Fourteen papers are included; separate abstracts have been prepared for 2. The remaining 12 papers cover such topics as electric arcs and MHD flows. (T.F.H.)

For abstracts of individual papers see: 15847 and 16295.

16295 MOTION OF THE PLASMA COLUMN IN THE INTERIOR AND AT THE EXIT OF AN ARC JET. Gerhard Kruelle. p.903-34 of CONF-752(Pt.II).

In order to explain pulsations observed in the operation of arc-jet engines, the transient behavior of the plasma column in the interior and at the exit of such an engine has been studied, by use of a high-speed camera. In addition, the transient arc voltage was recorded. Argon, nitrogen, helium, and hydrogen were used as propulsion gases. It is shown that there exist three different modes of discharge: stationary discharge with a diffused arc terminus at the anode; stationary discharge with a discrete fluctuating terminus; and quasi-stationary discharge with current transport by many small discrete arc threads. With argon, all modes of discharge were realized, the stationary mode corresponding to an increased mean power. In principle, helium showed a similar behavior, whereas the two molecular gases were seen to incline to the quasi-stationary mode. The type of flow (laminar or turbulent) in the throat region was found to be a criterion for the mode of discharge. (auth)

16296 PROCEEDINGS OF THE SYMPOSIUM ON ELECTRON AND VACUUM PHYSICS, HUNGARY, 1962. Budapest, Akadémiai Kiadó, Publishing House of the Hungarian Academy of Sciences, 1963. 506p. (CONF-620001)

The production and measurement of high and ultrahigh vacuum, the preparation of various cathode types and substances, electric currents passing through vacuum and gases, plasma physics, electric discharges in gases, and electron optics are discussed. Separate abstracts are prepared for 6 of the 55 papers presented. (C.E.S.)

For abstracts of individual papers see: 15550, 15740, 15925, 16297, 16298, and 16453.

16297 ELECTRON OPTICAL PROPERTIES OF COMBINED ELECTRIC AND MAGNETIC QUADRUPOLE LENSES. S. Ya. Yavor (Ioffe Inst. of Physics and Tech., Leningrad). p.125-37 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963. (In Russian)

Systems consisting of two and four combined lenses are discussed, and a system of four quadrupole lenses (an analog of axially symmetric lenses) which is capable of wide variations is suggested. The chromatic aberrations of combined quadrupole lenses are analyzed, and a combined quadrupole system with a negative chromatic (and achromatic) aberration is suggested. (tr-auth)

16298 ON THE ELECTRON-OPTICAL PROPERTIES OF MAGNETIC CYLINDRICAL LENS. Miklosh Siladi (Inst. of Technical Physics, Budapest). p.415-22 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963. (In Russian)

A theoretical analysis was made of a magnetic cylindrical lens with the antisymmetry plane consisting of four magnetic slits. The field of the system and trajectories of the divergent and parallel electron beams were calculated. The coordinates of the rectilinear image center distributed in the plane in relation to the lens field were determined. (tr-auth)

16299 FREQUENCY IMPULSE MODULATION AS A MEANS OF ATTAINING ACCURACY IN CESIUM ATOMIC CLOCKS. R. S. Badessa, V. J. Bates, and C. L. Searle (Massachusetts Inst. of Tech., Cambridge). 20p. (CONF-640610-1)

From Conference on Precision Electromagnetic Measurements, Boulder, Colo.

An electronic system was developed which corrects for cavity detuning errors in cesium atomic beam frequency standards. The r-f signal applied to the beam tube is square-wave phase modulated (frequency-impulse modulated). The transient response of the beam tube to these phase steps is used as a control signal. When the positive and negative transients are both equal in area and identical in shape, then it will be shown that the applied r-f signal must be exactly at cesium frequency (for the given magnetic field) and the r-f cavities must be exactly in tune. Two feedback loops are needed, one for correcting the crystal oscillator, and the other for adjusting the relative phase of the r-f cavities. With cavity detuning error greatly reduced by this system, the remaining source of inaccuracy is the uncertainty of the magnetic field in the drift region of the beam tube. An experiment is described which may permit setting a given cesium beam standard to a frequency that differs by a precisely known amount from the zero-field cesium resonance frequency. (auth)

16300 PROCEEDING OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, 1964, CHANDIGARH, FEBRUARY 24–FEBRUARY 28, 1964. PART B. SOLID STATE PHYSICS. Bombay, Atomic Energy Establishment, 1964. 303p. (CONF-640202(Pt. B))

Forty-five papers are included; separate abstracts have been prepared for 14. One paper was previously abstracted for NSA; see abstract 18:42719. Papers not abstracted consider nuclear quadrupole moments and nuclear magnetic resonance in various compounds. (M.J.T.)

For abstracts of individual papers see: 15545, 15546, 15547, 15548, 15641, 15642, 15931, 16183, 16184, 16414, 16415, 16416, 16727, and 17067.

Accelerators

Refer also to abstract 16852.

16301 (LAL-1123) RAPPORT D'ACTIVITE (15 AVRIL–15 OCTOBRE 1964). (Report of Activity, April 15–October 15, 1964). (Laboratoire de l'Accélérateur Linéaire, Univ. de Paris, Orsay (France)). Dec. 1964. 57p. Dep.(mn).

Improvement and utilization of the accelerator are summarized, together with research progress on nucleon physics, nuclear spectroscopy, pion physics, and storage rings. Development of storage rings and associated experimental equipment and radiation control are also reported. A bibliography of the publications during this period is appended. (J.S.R.)

16302 (SGAE-G-2/1964) PHYSIKALISCHE UND TECHNISCHE ASPEKTE VON KERNTEILCHENBESCHLEUNIGERN ULTRAHOHER ENERGIEN. (Physical and Technical Aspects of Nuclear Particle Accelerators of Ultrahigh Energy). M. J. Higatsberger (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf (Austria)). [1964]. 11p. (CONF-640401-1). Dep. (mn).

From 10th Metallography Colloquium, St. Christoph on Arlberg, Ger.

The physical and technical aspects of ultrahigh-energy accelerators are briefly reviewed with a discussion of the purposes of high energy physics, the physical fundamentals of various accelerator types, accelerator parameters and costs, and construction materials. (J.S.R.)

16303 INVESTIGATION OF ELECTRON SYNCHROTRON MAGNETIC AND ACCELERATING SYSTEMS BY MEANS OF BEAM ANALYSIS DATA. I. P. Karabekov. At. Energ. (USSR), 18: 18-22(Jan. 1965). (In Russian)

A method is suggested for selecting and analyzing data on the beam, center of gravity in the accelerator vacuum chamber. The results of the beam analysis were used for determining the deviations of certain basic parameters in an electron synchrotron. (tr-auth)

16304 PHASE STABILITY OF A PARTICLE SYSTEM IN AUTOMATICALLY CONTROLLED ACCELERATORS. E. A. Zhil'kov and A. N. Lebedev. At. Energ. (USSR), 18: 22-8(Jan. 1965). (In Russian)

The problem of phase stability of the particle system in a cyclic accelerator with an automatically controlled accelerating field frequency was studied. Kinetic equations were developed for nonlinear synchrotron oscillation stability in an arbitrary automatic control system. General stability criteria were found. (tr-auth)

16305 PHASE STABILITY OF A PARTICLE CLUSTER IN AUTOMATICALLY CONTROLLED ACCELERATOR. E. A. Zhil'kov. At. Energ. (USSR), 18: 58-9(Jan. 1965). (In Russian)

The stability of small particle clusters in automatically controlled accelerators and stability of the higher moments were investigated. For the first case the corrections were made not only for the center of gravity but also for the deviations of particle clusters from their equilibrium magnitudes $\psi^0 = V^0 = E$; $W^0 = 0$. The stability of higher moments was determined by self-attenuations (i.e. by the type of equilibrium function of the cluster distribution). The stability criterion for small clusters depends on the first, second, and third moments; the higher moments do not affect the stability at higher frequencies. The stability of the small cluster was determined by the center of gravity criteria. (R.V.J.)

16306 A SIMPLE METHOD FOR MEASURING FREE TRANSVERSE OSCILLATION FREQUENCIES IN A SYNCHROTRON. S. A. Kheifets and S. K. Esin. At. Energ. (USSR), 18: 60(Jan. 1965). (In Russian)

An attempt was made to measure particle transverse oscillation frequencies by inducing in the equilibrium orbit local, time-independent perturbations. The equations developed with the assumption of local perturbation in the azimuth show that with the induced local perturbations the frequency of orbit distortions is equal to the betatron oscillations. (R.V.J.)

16307 HIGH-VOLTAGE INJECTION SYSTEM FOR BETATRONS AND SYNCHROTRONS. A. P. Komar and O. P. Korovin (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 159: 775-6(Dec. 1, 1964). (In Russian)

Existing methods of high-voltage injection are briefly discussed. It is indicated that the optimum pre-acceleration energy is about 2.0 Mev. An injector is then described in which a microwave resonator is used for acceleration. Two types of resonators were used, elliptic with truncated and rectangular cones. The resonators were made of 0.3 mm copper and had unloaded Q ~ 7,000. Preliminary tests were made at injection energies 35 kev (resonator off) and 500 kev (resonator on), and stable capture was obtained in both cases. On going from 35 to 500 kev, the gamma intensity increased by approximately one order of magnitude. An advantage of such an injector is that it can be placed very closely to the accelerator. (ATD)

16308 FUNDAMENTAL STUDIES ON HEAVY ION REACTIONS. II. THE EXTRACTIONS OF 3 Mev He AND 10 Mev C IONS SUBHARMONICALLY ACCELERATED WITH THE CYCLOTRON OF KYOTO UNIVERSITY. Genshikaku Kenkyu, 9: 363-73(Aug. 1964). (In Japanese)

The 3.3-Mev He and 10-Mev C ions that were third subharmonically accelerated with the 105-cm cyclotron were detected with a silicon solid-state detector. The optimum values of the deflector voltage and the Q-magnet current are given. The effective charge of 8-Mev C ions during the passage of aluminum and silicon foils was measured as 4.2+. The nuclear plates were also used to detect the 10-Mev C ions. (auth)

16309 ION OPTICS OF THE ACCELERATING TUBES WITH NON-UNIFORM FIELDS. P. Croitoru (Inst. of Atomic Physics, Bucharest). Nucl. Instr. Methods, 33: 39-44(Mar. 1, 1965).

The methods of numerical integration of the path equation are discussed; the transfer matrix for the whole tube is constructed, and important conclusions with respect to the dependence of the emergent beam parameters on the accelerating potential and on the intermediate lens type are drawn. (auth)

16310 ON CURRENT LOAD OF RESONANT ACCELERATORS. A. Paulin. Nucl. Instr. Methods, 33: 53-6 (Mar. 1, 1965). (In German)

The effect of particle current through resonant cavities can be represented by lumped circuit elements. The mismatching of resonant cavities through particle injection can be compensated by a fast phase shift in the r-f transmission line, lengthening the line in the range from 70 to 90°. The amount of phase shift is not critical. No amplitude jump in the moment of the injection is necessary if the emitter is tuned higher than the unloaded cavities. For optimum operation frequency modulation is necessary. (auth)

16311 THE ACCELERATION OF DOUBLY-IONIZED He^3. N. R. Roberson, D. R. Tilley, and H. R. Weller (Duke Univ., Durham, N. C.). Nucl. Instr. Methods, 33: 84-6 (Mar. 1, 1965).

A convenient system for the acceleration by a Van de Graaff generator of doubly ionized ^{3}He was designed. The system consists of a standard r-f source followed by a 3.5° deflecting magnet. The magnet sweeps aside most of the singly-ionized beam, but allows the small (0.5%) doubly ionized beam to be accelerated. The system yields over 0.5 μamp of doubly ionized ^{3}He with a total accelerated beam of less than 10 μamp. (auth)

16312 ABSORPTION AND GENERATION OF RADIO-FREQUENCY POWER IN ELECTRON LINEAR ACCELERATOR SYSTEMS. J. Haimson (Varian Associates, Palo Alto, Calif.). Nucl. Instr. Methods, 33: 93-106(Mar. 1, 1965).

The design of high attenuation periodic microwave structures and their application during the past few years as internal collinear terminating loads for high power linear accelerator systems is described. An extension of these concepts for the development of small high vacuum loads which were located external to the actual accelerator waveguide and capable of absorbing high levels of r-f power without adversely affecting the matching characteristics of the system is also discussed. Avoidance of the pulse shortening or beam blow-up phenomena enables beam currents considerably greater than the maximum conversion efficiency value to be attained and this results in the regeneration of r-f power within the accelerator waveguide. Several examples of this condition and an analysis of the various beam induced power conditions in passive and positron phased non-uniform impedance circuits are presented. It is shown that in certain circumstances high current multisection machines, utilizing waveguide designs of differing conversion efficiency, can encounter beam induced electric field strengths sufficient to cause voltage breakdown. Exploitation of the stored energy mode of operation and demonstration of short pulses of beam current an order of magnitude greater than the steady state maximum conversion efficiency value is reported together with the associated capability of generating short pulses of very high r-f power by beam induction. (auth)

16313 A NANOSECOND PULSING SYSTEM IN USE WITH A VAN DE GRAAFF-ACCELERATOR. L. Beckman, R. B. Jansson, and B. L. Nilsson (Research Inst. of National Defence, Stockholm). Nucl. Instr. Methods, 33: 151-3(Mar. 1, 1965).

A 2.5- to 3-Mev Van de Graaff accelerator that produces proton pulses with a repetition frequency of 2 Mc is described. The pulses are produced by a crystal-controlled oscillator in the high voltage terminal of the accelerator and the pulse length is adjustable during operation down to about 10 nsec. The intensity on the target of the analyzed pulsed beam is 5 to 20 μamp depending among other things upon the condition of the ion source. The maximum peak

current in the pulse is close to 1 mamp. The general arrangement of the bunching system is shown. (C.E.S.)

16314 ANALYTICAL DETERMINATION OF THE LONGITUDINAL GEOMETRY OF A STANDING-WAVE LINEAR ACCELERATOR. A. Chabert and B. Veyron (Universite, Lyon). Nucl. Instr. Methods, 33: 154(Mar. 1, 1965).

A method for the analytical determination, in the non-relativistic case, of the lengths of successive gaps and drift-tubes in a standing-wave linear accelerator is presented. The method is based on a new definition of the stable phase which allows a very simple calculation in the case when the field is constant along the axis of the gaps. (C.E.S.)

16315 INITIAL OPERATION OF THE MILAN AVF CYCLOTRON. E. Acerbi, M. Castiglioni, G. Dutto, et al. (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 35: 1254-5(Feb. 16, 1965).

The 166-cm cyclotron was operated for the first time on January 19, 1965. Protons were accelerated to an energy in excess of 40 Mev. The operating conditions are summarized, together with beam observations. (D.C.W.)

16316 MECHANICAL PROCESS OF PARTICLE ACCELERATION INVOLVING THE SLOW TRANSVERSE WAVE IN AN ELECTRON BEAM. D. C. dePackh (Naval Research Lab., Washington, D. C.). Phys. Rev. Letters, 14: 94-6(Jan. 25, 1965).

A mechanism for acceleration of ions is studied, involving transverse velocity transfer between electrons in a beam and a number of positive ions small enough that their mass and charge per unit length of beam is negligible in comparison with those of the electron. (D.C.W.)

16317 PHYSICAL PRINCIPLES OF EXPERIMENTS WITH COLLIDING ELECTRON-POSITRON BEAMS. A. A. Komar, E. M. Leikin, Yu. N. Metal'nikov, E. M. Moroz, and V. A. Petukhov. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 222-95(1964). (In Russian)

Electrons and positrons with energies of about 200 Mev can be produced by irradiating in turn two fixed targets within a high-vacuum chamber. The electrons and positrons can be stored in a single storage ring in a synchronized system. The transverse and longitudinal dimensions of the particle bundles, the energy and angular dispersion of particles, the damping decrements of the osillations, etc., are analyzed in detail. The main reasons for particle losses in the storage ring are bremsstrahlung radiation and single scattering on the residual gas at a vacuum of 5×10^{-10} mm Hg std. The general background in the storage ring can be decreased by two orders of magnitude in determining the point at which the particles die. This low background is necessary in studying physical processes having a low cross section ($< 10^{-34}$ cm^2). The high-frequency accelerator system need not be synchronized with the high-frequency storage system. Design parameters are given for particles having energies of 150 and 500 Mev. A number of possible two-particle reactions with colliding beams are analyzed. Form factors for a number of strongly interacting particles are derived. Count rates are estimated for a number of reactions, and it is shown that the cosmic background will not interfere with the study of these processes. (TTT).

16318 A CURRENT INTEGRATOR FOR EXPERIMENTS ON AN ELECTRON LINEAR ACCELERATOR. Josef Foh (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys., 18: 14-15(Nov. 5, 1964). (In German)

A device was constructed from commercial units, which measures the charge collected in a beam catcher and simultaneously indicates the average electron current. Numerical values for the current were obtained with an analog-to-digital frequency converter. The result is preselected and is fed into a data processing system. The electron currents lie between one namp and one μamp, the charge between 1 amp-sec and 1000 μamp-sec. The error lies under 0.5% by a suitable choice of the measuring range. (tr-auth)

16319 MEASUREMENT OF THE ELECTRON CHARGE CIRCULATING IN A SYNCHROTRON DURING THE BETATRON OPERATION PERIOD. N. S. Solov'ev (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 34: 2181-4(Dec. 1964). (In Russian)

An electromagnetic belt with a ferromagnetic core was used to measure the electron charge circulating in the orbit of the 680-Mev S-60 synchrotron. The electron current, for various reasons, fluctuates in value, which, obviously leads to corresponding changes of its magnetic field. The electromagnetic belt consists of two rods, assembled of ring-like magnetodielectric elements; the rods are mounted opposite each other in the rectilinear section of the vacuum chamber, next to the electromagnet pole pieces. Thus, the belt is located in the periodically increasing stray field of the electromagnet. The betatron acceleration period being 15 μsec and the rate of increase of the magnetic field being 2×10^4 Oe/sec, it may be assumed that there is no significant change of the field during the measurement period. The measurement results are given only in qualitative form: oscillograms of the belt amplifier output. The belt was used to establish the relation between the magnitude of the current circulating in the accelerator during betatron operation and the current injected into the synchrotron (the injector is a pulse transformer), and to measure the electron current with the high-frequency (synchrotron) system turned on and cut off. It is estimated that the belt with a ferromagnetic core has a higher sensitivity than a belt without such a core and that the frequency distortion of the equipment does not exceed 10%. This type of belt may also be of value in determining the charge circulating in other circular-type accelerators. (ATD)

16320 A LINEAR ACCELERATOR AS A POSSIBLE SOURCE OF ELECTRONS IN AN ELECTRON MICROSCOPE. G. I. Zhileiko. Zh. Tekhn. Fiz., 34: 2185-7(Dec. 1964). (In Russian)

Whereas the maximum accelerating potential available in conventional electron microscopes is of the order of 30-50 kv, for many studies it would be desirable to have a source of electrons with energies up to 1-2 Mv. However, at present the exceptional electron microscopes with such superhigh potentials are extremely bulky installations, taking up hundreds of cubic meters, owing to the volume occupied by the superhigh d-c voltage supply and provisions for appropriate insulation. It is suggested that some of the difficulties can be overcome and the volume of the installation reduced to 5-10 m^2 by using an electron accelerator as the source. To date the chief impediment has been the energy spread of accelerators: of the order of 10^{-2}, whereas the acceptable limit is $10^{-4}-10^{-5}$. Accordingly, there is examined theoretically the possibility of reducing the electron energy straggling in the case of a travelling-wave type accelerator. It is concluded that by appropriate measures it should be feasible to reduce the energy spread (theoretically, virtually to zero), mainly by monoenergizing the injected electrons. Means for realizing this are suggested. It is concluded, therefore, that potentially a suitably designed electron accelerator can be used as a source of high-energy electrons for electron microscopy. (ATD)

16321 CHOICE OF THE OPTIMUM PHASE VELOCITY OF THE WAVE IN A LINEAR ELECTRON ACCELERATOR. V. A. Vishnyakov and E. K. Ostrovskii. Zh. Tekhn. Fiz., 34: 2188-90(Dec. 1964). (In Russian)

As has been shown in earlier studies, short accelerators with a fixed phase velocity, close to the speed of light, have a number of advantages over buncher waveguides with a variable phase velocity, particularly in employing high-frequency high-power sources; they can be used not only independently, but also as injectors for high-energy linear accelerators. For each combination of initial energy, value of the accelerating field, and waveguide length there is a certain optimum phase velocity of the wave. This is illustrated by appropriate curves, showing the variation in electron energy and phase over the length

of an accelerator for different values of the phase velocity (0.94 c, 0.97 c, and c). The optimum phase velocity values for a wide range of initial energies and accelerating potentials in an iris waveguide 85 cm in length were calculated. This length is a compromise choice to provide for a 4-6 Mev output energy and a sufficient acceptance angle. The variation in initial energies was 80 to 160 kev; the range of accelerating fields from 50 to 120 kv/cm. The results are presented in the form of families of curves, which should be useful in choosing the optimum phase velocity in designing accelerators with an 85 cm long iris waveguide. (ATD)

16322 PRODUCTION OF He^3 ION BEAMS WITH A VAN DE GRAAFF ACCELERATOR. N. Sarma and M. G. Betigeri (Atomic Energy Establishment, Trombay, India). p.174-7 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Advantages of using ^3He ion beams for nuclear reaction studies are high Q-values, high momentum transfer, and production of proton-rich residual nuclei. Problems in the efficient utilization of the gas are discussed, such as contamination by HHH^+, HD^+, and T^+, and maintenance of low pressure by a sufficiently intense r-f exciting field. The design of a reliable thermomechanical leak is described. (M.J.T.)

16323 PARTICLE ACCELERATORS. Lawrence H. Lanzl. p.615-50 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964.

The physical principles and components basic to all particle accelerators are reviewed and design features of cyclic and linear accelerators are described. A brief discussion is included of medical and biological uses of accelerators including supervoltage therapy. Dose distributions obtained using 10-mev electrons from a linear accelerator are compared for those using a ^{60}Co γ source. (35 references) (C.H.)

16324 ULTRAHIGH VACUUM FOR STORAGE RINGS FOR 28 Gev PROTONS. E. Fischer (CERN, Geneva). 17p. (CONF-640903-8)

From American Vacuum Society Symposium, Chicago.

The addition of a pair of intersecting storage rings to the 28-Bev CERN proton synchrotron was proposed. Accelerated protons injected into both rings would circulate in opposite directions and could collide at eight points where the rings intersect. The working principle, general layout and expected performance figures of the proposed research facility are given. The average residual gas pressure in the system must be 10^{-9} torr in order to have a useful lifetime of about 12 hr. In the colliding beam areas even a pressure of 10^{-10} to 10^{-11} torr is very desirable in order to keep the background from residual gas scattering low enough for the observation of p-p scattering. The basic concept of the ultrahigh vacuum system for the intersecting storage rings is described. Experimental studies on the main vacuum problems have been started. (auth)

16325 THE SACLAY DESIGN STUDY OF PROTON LINEAR ACCELERATORS. M. Prome (Centre d'Études Nucléaires, Saclay, France). 19p. (CONF-650-13)

From Linear Accelerator Conference, Stoughton, Wis., July 1964.

Information is presented on the studies undertaken in the development of a 200- and a 20-Mev linac. The information includes theoretical studies, models, preinjector design, and a general survey of the 200-Mev linac project. (D.L.C.)

Astrophysics and Cosmology

Refer also to abstracts 15832, 16737, 16741, 16748, and 16761.

16326 (REIC-37) THE SPACE-RADIATION ENVIRONMENT AND ITS INTERACTIONS WITH MATTER. E. R. Leach, B. P. Fairand, and L. H. Bettenhausen (Radiation Effects Information Center, Battelle Memorial Inst., Columbus, Ohio). Jan. 15, 1964. 105p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Space-radiation data are summarized and evaluated. Radiation-measurement techniques are discussed, and the apparatus used on several American space probes and satellites is described. Particle flux as a function of type of radiation and energy is summarized in graphic form, and basic concepts of the interaction of space radiation with matter are discussed. (auth)

16327 ON THE EARLY DEVELOPMENT OF THE METAGALACTIC SYSTEM. Bjoern Bonnevier (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 27: 305-11(1965).

Some problems related to the early development of the metagalactic system are discussed along the lines put forward by Klein. The final equations derived in a paper by Alfvén and Klein are solved. Within the framework of this theory, it is shown that a contraction of the metagalaxy might be converted to an expansion in agreement with observed redshifts. (auth)

16328 THE OPTICAL SPECTRUM OF 3C 273. J. B. Oke (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 141: 6-18 (Jan. 1, 1965).

Photoelectric spectrophotometric observations of both the continuum and emission lines in the spectrum of 3C 273 were obtained using spectrum-scanning instruments. Observations cover the wavelength range from λ = 3200 to 10800 Å. For laboratory wavelengths to the blue of λ = 5500, the entire continuous spectrum and the hydrogen emission lines can be explained in terms of a hot hydrogen nebula at an electron temperature of 160,000°K. In this model the total thermal emission is 2.3×10^{46} erg sec^{-1}, and most of the oxygen is required to be in the form of O^{3+}. The continuous spectrum can also be explained in terms of a hydrogen nebula at an electron temperature of about 14,000°K, but in this case it is necessary to add arbitrarily a flat spectrum, such as synchrotron radiation, which must account for more than 90% of the continuous spectrum. In this latter model, the observed hydrogen lines are somewhat too strong. To the red of the laboratory wavelength λ 5500 there is in all models a strong excess of radiation which should probably be associated with the observed radio-frequency synchrotron emission. Assuming the high electron-temperature model to be correct, one is led on the basis of the observed light fluctuations to a nebula with a radius of only a few parsecs and a mass of 2×10^7 solar masses. At the density implied by such a model, electron scattering is very important and makes it even more difficult to explain the light variations. Kinetic energy of expansion is sufficient for at most 10^4 years so that 3C 273 is either younger than 10^4 years, or there is a continuous supply of energy being provided. If the light variations could be disregarded, the best model from the standpoint of the observations would have an electron temperature of 160,000°K, a diameter of 2000 pc, and a mass of 10^{11} solar masses. (auth)

16329 OBSERVATIONS OF THE SIX MOST INTENSE RADIO SOURCES WITH A 1.0′ FAN BEAM. A. R. Thompson and T. Krishnan (Stanford Univ., Calif.) Astrophys. J., 141: 19-33(Jan. 1, 1965).

Observations of the radio sources Cassiopeia A, Taurus A, the Orion Nebula, the Omega Nebula, Sagittarius A, and Cygnus A were made with a beam width of 1.0′ in the east-west direction using the Stanford compound interferometer. The adjustment of the phase lengths of the lines and amplifiers was carried out with the aid of modulated reflections from gas-discharge tubes and diodes. The right ascensions and widths of the sources are in good agreement with values from three other fan-beam surveys. The radio emission in Cassiopeia A is generated in a region resembling a hollow spherical shell. The radius of the shell measured at maximum emissivity is 2.0′, and the thickness of the shell at the half-emissivity level is 0.45 of the radius

In Taurus A the emissivity is a maximum near the center of the source and decreases outward. The right ascension of the maximum radio brightness in the Orion Nebula coincides with that of the hottest exciting star, θ^1(C) Orionis, and a second smaller peak coincides in right ascension with the second hottest star, θ^2(A) Orionis. There is good agreement between the radio and optical emission measures near the center of the nebula. The Omega Nebula and Sagittarius A both show complex profiles which suggest that their structure is not fully resolved. The maximum radio brightness in the Omega Nebula is displaced from the optical center of the nebula by 23 sec of right ascension to the west. In Sagittarius A the maximum brightness is 4 sec of right ascension to the east of the origin of the revised galactic coordinates. The centroids of the two main components of Cygnus A are separated by 99″ in the east-west direction, and the flux density of the eastern component is 15% greater than that of the western component. (auth)

16330 BARYON STAR MODELS. Cullen L. Inman (Goddard Inst. for Space Studies, New York and New York Univ., New York). Astrophys. J., 141: 187-94(Jan. 1, 1965).

Large masses consisting of identical baryons (whose mass is taken to be that of the neutron) are considered in the framework of general relativity. Four assumptions are made as to their interactions, leading to four equations of state, and for each the masses and radii of a number of configurations are calculated for various values of the central number density. The relations of the mass to a parameter t_0 ($\simeq 4 \sinh^{-1}[\hbar/m_B c(3\pi^2 n_0)^{\frac{1}{3}}]$, where n_0 is the central number density) for each of the four equations of state are strikingly similar. (auth)

16331 A MODEL FOR A HOMOGENEOUS STAR OF MODERATE MASS. Alfred H. Bennick and Lloyd Motz (Hunter Coll., New York). Astrophys. J., 141: 195-200 (Jan. 1, 1965).

A method for obtaining a set of integration variables which are consistent on both sides of the interface between the central convective core and radiative envelope of a stellar model is derived. It is shown that, once the core size and the composition are chosen, the set of variables is a function of a single free parameter, δ, the ratio of the energy generated by the carbon cycle in the convective core to the energy generated by the proton-proton chain in the core. This set of variables is then used to construct a stellar model that has a convective central core, a radiative zone, and an outer convective layer. If the core size is increased, the mass and luminosity of the model that is obtained also increase. If the parameter δ varies, the mass and luminosity are substantially unchanged but the radius varies, thus causing a change in the effective temperature of the model. By taking a fixed core size and varying δ from model to model, we obtain a series of models which are displaced horizontally on the HR diagram. In this way, a model for a homogeneous Population I star is obtained that lies on the initial main sequence. It also satisfies a mass-luminosity relationship based on a few relatively well-established stellar masses. Its surface characteristics are M = 1.48 M⊙, R = 1.16 R⊙, L = 4.46 L⊙, and T_e = 7750°K. Its interior characteristics are $T_c = 18.2 \times 10^6$°K, $P_c = 2.17 \times 10^{17}$ dynes/cm^2, and ρ_c = 87.3 gm/cm^3. Ninety per cent of its energy is generated by the proton-proton cycle. It has a central convective core out to 8 per cent of its radius, a radiative zone from 8 to 96 per cent, and an outer convective layer for the remaining 4 per cent of its radius. This shows that the Naur-Osterbrock conclusions do not hold if the opacity formulae are sufficiently complex. (auth)

16332 THE MOTION OF GASEOUS STREAMS IN THE BINARY SYSTEM. Su-shu Huang (Goddard Inst. for Space Studies, New York and Catholic Univ. of America, Washington, D. C.). Astrophys. J., 141: 201-9(Jan. 1, 1965).

Several problems were studied in connection with the gaseous flow in the close binary system. First, the statistical property of the Jacobian constants of colliding particles in the system is examined and the constancy of their mean value during collisions is established. Then the velocity-independent nature of the rate of change in angular momentum of a particle moving in the binary system is pointed out. For the gaseous flow a set of differential equations is derived that provides a point of view lying between the orbital approach (which neglects both pressure and collision) and the hydrodynamic approach (which includes both) because the equations take into account the collision but not the pressure. The equations were solved under the same approximation as Prendergast (1960) used and were found to yield a result similar to that obtained by him from the hydrodynamic equations. Because of the emphasis on the Jacobian constant and angular momentum in the treatment of gaseous flow, the fact is stressed that some combinations of these two physical quantities are incompatible in a certain region of space that is called the "forbidden zone." Finally, the formation, the evolution, and the significance of rotating rings observed in many Algoltype eclipsing binaries are discussed in an effort to understand the mode of ejection of matter from the secondary surface. (auth)

16333 FILAMENTARY STRUCTURE IN SOLAR PROMINENCES. Lowell R. Doherty and Donald H. Menzel (Harvard Univ., Cambridge, Mass.). Astrophys. J., 141: 251-71(Jan. 1, 1965).

Isobaric steady-state models of prominence filamentary structure similar to the models of Orral and Zirker were calculated. The models have cylindrical symmetry and contain uniform longitudinal magnetic fields. Thermal conduction transverse to the field balances the net gain or loss of radiative energy at each point of the filament. To obtain models with central temperatures lower than Orral and Zirker's 30000°K an approximate treatment of radiative transfer in the resonance lines of H I, He I, and He II was included, as well as radiative losses from heavy ions and the effects of absorption of chromospheric and coronal radiation. It was found that filaments of observable width are possible for certain values of the axial temperature. At densities corresponding to $\phi \equiv N_1 T = 2 \times 10^{13}$, 2×10^{14}, 2×10^{15}, respectively, the axial temperature must lie near 15600, 12100, and 9600°K. The models of wide filaments have broad, almost-isothermal, central regions. The temperature rise to the corona occurs in a thin shell. That part of the filament below 30000°K is stable against temperature perturbations if the magnetic field has a strength of at least 1 gauss. Above 30000°K in the shell, the conditions for stability continue to hold if the mean free path of the neutral particles remains small compared with the shell thickness. The shells of the models become very thin for magnetic fields ≥1 gauss. Without further investigation of the heat transport and the mechanism that heats the normal corona, it cannot be determined whether real filaments are entirely stable. Stability considerations alone do not set a satisfactory upper limit on the width of filaments. The possibility that filament size depends on a balance of the radiative losses in the shell with the energy available to heat the corona is discussed. (auth)

16334 THE "POLAR CROWN" OF FILAMENTS AND THE SUN'S POLAR MAGNETIC FIELDS. Charles L. Hyder (Univ. of California, Los Angeles). Astrophys. J., 141: 272-3(Jan. 1, 1965).

The synchronism between the prominence-filament "rush to the poles" and the times of reversal of the polar magnetic fields is shown for the last maximum of solar activity (1957–1958). (auth)

16335 THE "DOUBLE LIMB" IN Hα. Rawi Bhavilai, D. G. Norton, and R. G. Giovanelli (Commonwealth Scientific and Industrial Research Organization, Sydney and Australian National Univ., Canberra). Astrophys. J., 141: 274-6(Jan. 1, 1965).

Photographs of the solar chromosphere in monochromatic light of pass band 1/8 Å centered on Hα show that the well-known "double limb" vanishes on eliminating all traces of

the surrounding continuum. The inner limb is spurious and is simply an image of the photosphere in stray light of unwanted wavelengths. (auth)

16336 THE UV LINES OF Fe XIV IN THE SOLAR CORONA. R. Stockhausen (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 141: 277-81(Jan. 1, 1965).

Relative line strengths of the u-v lines of Fe XIV are calculated for the solar corona. Collisional excitation, followed by radiative transitions to the ground term, is assumed to take place. The effect of the inclusion of an estimated exchange term in the collision cross-section is considered. Calculations are made with a range of values of the exchange term and temperatures. The exchange term seems to have little effect on the line strengths. The relative line strengths are compared with observations of the satellite OSO-1. The range of values of calculated line strengths is much greater than the observed line strengths. The possibility of self absorption in an inhomogeneous corona is suggested. (auth)

16337 MEASUREMENTS OF THE RATIO OF Li^6 TO Li^7 IN TWO MAGNETIC STARS AND FOUR NORMAL STARS. George Wallerstein (Univ. of California, Berkeley). Astrophys. J., 141: 311-14(Jan. 1, 1965).

The wavelength of the resonance line at 6707 Å was measured in two magnetic stars and four normal stars. The results were used to determine the $^6Li/^7Li$ ratios for the stars. The magnetic stars have significantly more ^6Li than the normal stars. (D.C.W.)

16338 ON THE OPTICAL IDENTIFICATION OF ELEVEN NEW QUASI-STELLAR RADIO SOURCES. Allan Sandage and John D. Wyndham (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 141: 328-31(Jan. 1, 1965).

The positive identification of five quasi-stellar radio sources is reported, together with the probable identification of six other sources. Radio position data for the eleven sources are included. (D.C.W.)

16339 OPTICAL POSITIONS OF EIGHT QUASI-STELLAR OBJECTS ASSOCIATED WITH RADIO SOURCES. P. Veron (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 141: 332(Jan. 1, 1965).

The results of measurements of the optical positions of seven of the eleven sources discussed in the preceding letter are given. (D.C.W.)

16340 THE SPECTRUM OF 3C 273. F. J. Low and H. L. Johnson (Univ. of Arizona, Tucson). Astrophys. J., 141: 336-7(Jan. 1, 1965).

The results of brightness measurements on 3C 273 and of flux calculations for 3C 273 are presented; and the spectrum of 3C 273 is plotted from infrared, optical, and radio data. (D.C.W.)

16341 CORRELATIONS BETWEEN A DEPOSIT OF LEAD-210 IN THE ANTARCTIC AND SOLAR ACTIVITY. Gerard Lambert, Mehdi Nezami, and Jacques Labeyrie (CEN, Saclay, France and Centre des Faibles Radioactivities, Gif-sur-Yvette, France). Compt. Rend., 260: 619-22 (Jan. 11, 1965). (In French)

The concentration of ^{210}Pb along a core sample of neve from Antarctica was measured so that the date of formation of the different levels could be determined. It was thus established that the concentration of the ^{210}Pb in the snow, restored to the moment of precipitation, passes through a maximum after each of the five last maxima of solar activity. (tr-auth)

16342 LITHIUM-4 AND THE ANOMALOUS pp-CYCLE. G. E. Kocharov (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSR, Ser. Fiz., 28: 1721-3 (Oct. 1964). (In Russian)

The possibility that the "anomalous pp-cycle," $p(p,\beta^+)d(p,\gamma)He^3(p,\gamma)Li^4(\beta^+)\alpha$, may contribute to energy generation in main sequence stars is discussed. Laboratory data relating to the existence of ^4Li are briefly reviewed, and it is concluded that the available data do not exclude the possibility that ^4Li may exist. The anomalous pp-cycle leads to copious production of high-energy neutrinos. The rate of the $^{37}Cl(\nu,e^-)^{37}Ar$ reaction due to solar neutrinos at the location of the earth was calculated as a function of the central temperature of the sun with several hypotheses concerning the mechanism of energy generation. From these calculations and the finding of Davis that the rate of this reaction is less than 10^{-33}/sec, it is concluded that either the anomalous pp-cycle does not occur in the sun, or the temperature at the center of the sun exceeds 25×10^6 °K and the carbon-nitrogen cycle contributes appreciably to the energy generation. Further investigation of nuclear reactions with sensitive detectors will be required to settle the question of the existence of ^4Li. (ATD)

16343 THE MAGNETOHYDRODYNAMIC WAKE OF THE MOON. Norman F. Ness (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 70: 517-34 (Feb. 1, 1965).

The possible detection of the lee wake of the magnetohydrodynamic interaction of the solar wind with the moon as observed by the Imp 1 satellite is discussed. The interplanetary magnetic field was found to fluctuate very rapidly and reach anomalously large values when the satellite was approximately eclipsed by the moon in December 1963. Later data on the interplanetary field in February 1964 suggest that a detached lunar shock wave analogous to that observed by Imp 1 associated with the earth may not be a permanent feature of the lunar environment. The approximate length of the wake region behind the moon is 150 lunar radii; at this distance the diameter of the region is about 70 lunar radii. Related studies on 29.5-day periodicities of K_p are reviewed. The solar wind interaction with the geomagnetic field extends the magnetosphere far behind the earth. Hence lunar synodic periodicities in K_p may reflect the interaction of the moon with the earth's magnetic tail rather than the moon's wake with the earth. 70 references. (auth)

16344 FISSIOGENIC XENON FROM THE PASAMONTE METEORITE. M. W. Rowe and P. K. Kuroda (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 70: 709-14 (Feb. 1, 1965).

Unambiguous evidence for fission-produced nuclides in meteorties was shown in the abundance pattern of the Xe isotopes from the Pasamonte meteorite. Calculation of the age of the meteorite from fissiogenic ^{136}Xe and uranium contents of the meteorite yields a value of $T' = 2 \times 10^{10}$ years, which seems far too large. The result of this calculation leads to the conclusion that part of the fissiogenic Xe in Pasamonte must have been produced by other fissionable nuclide(s), such as ^{244}Pu, in addition to ^{238}U. Assuming that the fissiogenic ^{136}Xe in Pasamonte is produced from spontaneous fission of ^{238}U and extinct ^{244}Pu, then Ξ, the time interval between the cessation of nucleosynthesis and formation of the meteorite, is estimated to be ~300 myr. (auth)

16345 COSMIC-RAY-PRODUCED IRON 60 IN ODESSA METEORITE. P. S. Goel and M. Honda (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 70: 747-8(Feb. 1, 1965).

The content of ^{60}Fe in a large sample of Odessa iron meteorite was measured by counting the daughter radionuclide ^{60}Co. Previous data on other cosmic-ray produced nuclides in the Odessa meteorite are compared with present results. (M.J.T.)

16346 A NEW CLASS OF RADIO SOURCE SPECTRA. W. A. Dent and F. T. Haddock (Univ. of Michigan, Ann Arbor). Nature, 205: 487-8(Jan. 30, 1965).

The flux densities of NGC 1275, 3C 273, and 3C 279 were measured at 8000 and 16500 Mc/sec. The results established an upward turn in the radio spectra at high frequencies. An interpretation of the high-frequency component of the spectra was attempted. (D.C.W.)

16347 NEUTRINOS IN THERMO-DYNAMICAL EQUILIBRIUM WITH ELECTRONS AND PHOTONS, AT HIGH TEMPERATURE. A. Wataghin (Universita, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 35: 1240-3(Feb. 16, 1965).

The energy densities and fluxes of antineutrinos and neutrinos at the high temperatures (10^9 to 5.93×10^{12} °K) in celestial objects were calculated, excluding the gravitational potential. Numerical results were obtained. The conditions for equilibrium of antineutrinos and neutrinos with electron pairs were derived. (D.C.W.)

16348 ENERGY LOSSES IN e^4 CAPTURE PROCESSES AT HIGH TEMPERATURE. G. Aschieri, M. T. Reineri, and G. Wataghin (Universita, Turin). Nuovo Cimento (10), 36: 296-9(Mar. 1, 1965).

The electron or positron capture processes (URCA process in central part of supernova) are examined taking into account the electron pair production at high temperatures ($kT \gtrsim mC^2$, where m is the electron mass). The energy losses in processes of generation of ν_e and $\overline{\nu}_e$ are calculated assuming that in a stellar body the weak interactions are not in a state of equilibrium and the neutrinos escape freely from the region of the star under consideration. (C.E.S.)

16349 REMARKS ON STATISTICS OF PARTICLES AND ANTIPARTICLES AT HIGH TEMPERATURE. G. Wataghin (Universita, Turin). Nuovo Cimento (10), 36: 300-3(Mar. 1, 1965).

The independent particle model of a statistical equilibrium at high temperatures is analyzed. A statistical equilibrium state of matter in a region interior to some celestial body with temperatures increasing step by step is considered. At each step new kinds of antiparticle pairs are produced in collisions giving rise usually to a number density of pairs of the same order as the number of photons per cm^3. (C.E.S.)

16350 RATES OF NUCLEAR REACTIONS IN SOLID-LIKE STARS. Richard A. Wolf (California Inst. of Tech., Pasadena). Phys. Rev., 137: B1634-43(Mar. 22, 1965).

In stellar matter as cool and dense as the interior of a white dwarf, the Coulomb energies between neighboring nuclei are large compared to the kinetic energies of the nuclei. Each nucleus is constrained to vibrate about an equilibrium position, and the motion of the nuclei in the interior of a white dwarf is similar to the motion of the atoms in a solid or liquid. A solid-state method is proposed for calculating the rate at which a nuclear reaction proceeds between two identical nuclei oscillating about adjacent lattice sites. An effective potential U (r) derived by analyzing small lattice vibrations is used to represent the influence of the Coulomb fields of the lattice on the motion of the two reacting nuclei. The wave function describing the relative motion of the two reacting particles is obtained by solving the Schrödinger equation containing the effective potential U (r). From this wave function, an expression for the reaction rate is derived. The rates of the p + p and $C^{12} + C^{12}$ reactions calculated using this solid-state method are typically 1 to 10 orders of magnitude smaller than those calculated by the method previously suggested by Cameron. (auth)

16351 ASYMPTOTIC BEHAVIOR OF COLD SUPERDENSE STARS. B. Kent Harrison (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B1644-?(Mar. 22, 1965). (LA-DC-6510)

The behavior of superdense (neutron) stars at absolute zero was studied. It is shown that, with certain assumptions about the equation of state, the mass and radius of such a star approach constants in an oscillatory fashion as the star's central density increases. The assumptions about the equation of state are: $dP/d\rho > 0$ everywhere, and for sufficiently high-density ρ, the pressure divided by the density P/ρ approaches a constant. These assumptions are physically reasonable, especially if one assumes a real speed of sound which is finite, but always less than the speed of light. The results show that there exists for such stars an infinite series of ranges of the central density, in which ranges $dM/d\rho_0$ alternates in sign, where M is the total star mass and ρ_0 is the central density. This indicates alternate local stability and instability; however, the total binding energy is positive for ρ_0 greater than $\sim 10^{16}$ g/cm^3, so that instability against large-scale deformation exists. A striking feature of the results is that their qualitative nature does not depend on whether or not the general relativistic form of the equations is used. The exact quantitative results do, of course, depend on the form of the equations, as well as on the exact equation of state used. (auth)

16352 GRAVITATIONAL COLLAPSE AND SPACE-TIME SINGULARITIES. Roger Penrose (Birbeck Coll., London). Phys. Rev. Letters, 14: 57-9(Jan. 18, 1965).

Gravitational collapse is discussed without assumptions of spherical symmetry. It is shown that after a certain critical condition has been fulfilled, deviations from spherical symmetry cannot prevent space-time singularities from arising. (D.C.W.)

16353 BALLOON OBSERVATION OF THE X-RAY SPECTRUM OF THE CRAB NEBULA ABOVE 15 kev. George W. Clark (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 14, 91-4(Jan. 25, 1965). (MIT-2098-108)

A source of cosmic x rays with energies above 15 kev was observed in a balloon flight conducted on July 21, 1964. It was concluded that the x rays probably came from the Crab nebula. The x-ray spectrum of the Crab nebula was determined approximately in the energy range from 15 to 60 kev. The results provide evidence against the idea that the x rays from the Crab nebula are the blackbody emission from the surface of a neutron star. (D.C.W.)

16354 THE CLASS 3 FLARE OF 26 SEPTEMBER 1963 AND ITS CENTRE OF ACTIVITY. Ian Elliott and John H. Reid (Dublin Institute for Advanced Studies). Planetary Space Sci., 13: 163-8(Feb. 1965).

The activity of the sunspot group which crossed the solar disk between September 14 and 26, 1963 is summarized. The Class 3 flare on September 26 is described, and its characteristics are compared with flares which have produced high-energy protons (>1 Bev). The absence of these high-energy particles from this flare is discussed. (auth)

16355 HELIUM FLASH IN LESS MASSIVE STARS. Daiichiro Sugimoto (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 703-25(Nov. 1964).

The structure of a stellar core of condensed type is generally discussed to show that physical variables at the center can be determined almost completely as functions of central entropy, if the polytropic index is known in the relatively central region. Based on this relation, the thermal runaway through the helium flash in less massive stars is investigated, treating the core mass as a parameter. Taking into account the finite thermal conductivity, a convection core is shown to develop in the degenerate region. If a sufficiently large efficiency of convective heat-transport is assumed, the maximum central temperature in the course of the helium flash is too low to lead the core of 0.53 $M_\odot$ to explosion, in contrast to the model sequence calculated by Schwarzschild and Härm. The effect of the finite efficiency of convective heat-transport is investigated, using the mixing length theory of convection and treating the ratio of the mixing length to the scale-height of pressure as a parameter. Structures of cores including this effect are solved numerically. It is found that, if this ratio is smaller than a critical value which depends on the core mass, an instability occurs; the heat energy liberated by helium burning is blocked and the central temperature reaches a value, above which the effect of inertia leads the core into explosion. (auth)

16356 MODEL-UNIVERSES IN HOYLE'S COSMOLOGY. II. THE WORLD-LINE OF FLUID MATTER. Hidekazu Nariai (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 32: 837-43(Nov. 1964).

The world-line of fluid matter in Hoyle's cosmology is

derived from Hoyle-Narlikar's field equations themselves in order to see if the co-moving nature of the coordinates in the Robertson-Walker metric is consistent with the world-line of fluid matter to be derived in such a manner. The answer is affirmative with a certain proviso. It is also revealed that there is an intimate connection between the behavior of the world-line thus derived and the classification of permissible model-universes. The problem of a test particle in an empty region which is regarded as the gravitational field accompanied by the creation-field is also considered. (auth)

16357 THEORETICAL MODELS OF CYTHEREAN AND MARTIAN UPPERATMOSPHERES. PART II. IONIZATION BY SOLAR RADIATION AND SOLAR WIND. Mikio Shimizu (Ochanomizu Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 868-70(Nov. 1964).

An attempt is made to determine the ionization rates for solar ionizing radiation and the solar wind in the upper atmospheres of Venus and Mars. Previous measurements on solar radiation were used in the investigation. (C.E.S.)

16358 A MODEL OF STAR-LIKE OBJECTS. Ko Aizu, Yoichi Fujimoto, Hiroichi Hasegawa, Satio Hayakawa, and Mituo Taketani (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 971-3(Dec. 1964).

A theory of star-like objects is summarized. It is proposed that the star-like objects are in an early stage of an explosion in the galactic nucleus, while the active galaxies are in subsequent stages of the explosion. Further, it is suggested that such an explosion is a necessary step in the evolution of most galaxies. A mechanism for the explosions in the nuclei of galaxies is proposed. (D.C.W.)

16359 MAGNETIC FIELDS IN INTERPLANETARY SPACE. L. J. Cahill, Jr. (Univ. of New Hampshire, Durham). Science, 147: 991-1000(Feb. 26, 1965).

Development of the concept of an interplanetary magnetic field, evidence of its existence, and the effects of this field are discussed. (P.C.H.)

16360 SOME COMMENTS ON THE SINGULARITIES OF THE COSMOLOGICAL SOLUTIONS OF THE GRAVITATION EQUATIONS. I. M. Khalatnikov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 261-71(Jan. 1965). (In Russian)

A class of solutions of the gravitation equations is found which possess a singularity in energy density for $t \to 0$. In a certain sense the equations are similar to the case of collapse of dust-like matter; a characteristic of theirs is that world particle lines in a synchronous reference system practically coincide with time lines. This is the case which one obtains when the energy density is independent of the coordinate for which scale contraction occurs. Solutions of Maxwell's equations for electromagnetic fields under anisotropic collapse conditions are analyzed. (auth)

16361 PHOTOPRODUCTION OF GRAVITONS ON SPINOR PARTICLES. V. N. Mironovskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 358-9(Jan. 1965). (In Russian)

The differential cross section for photoproduction of gravitons on spinor particles is calculated. The gravitational luminosity of stars related to this process is estimated. (auth)

16362 SOLAR ULTRAVIOLET AND X-RAY RADIATION. C. de Jager (Universitet, Utrecht). p.1-42 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

The different parts of the solar atmosphere contributing to observed uv and x radiation—the photosphere, chromosphere, quiet and active regions of the corona, and solar flares—are considered. Knowledge of these solar regions is summarized. Observations of uv and x radiation from these sources are reviewed and compared with theories. Possible future observations for the various spectral ranges are suggested. 96 references. (M.J.T.)

16363 SOLAR FLARES. M. A. Ellison and J. H. Reid (Dublin Inst. for Advanced Studies). p.43-63 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Statistics of solar flares observed and recorded during the IGY are discussed. Flare, spectral line width, and intensity development, especially the H_α flash phase, and the shapes and locations of flares are described. Various theories proposed for flare spectra are summarized. The plasma-discharge model of flare emission trajectories is discussed for the different type bursts. 56 references. (M.J.T.)

16364 SOLAR RADIO EMISSIONS. S. F. Smerd (Commonwealth Scientific and Industrial Research Organization, Sydney). p.65-97 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Research in solar radio astronomy before the IGY is reviewed, and some sample experimental results are presented. IGY observations and present knowledge and hypotheses are discussed for the quiet sun, slowly varying solar activity and radio plages, and bursts and storms in meter and microwave regions. It is described how the several types of bursts compound during different phases of a complete flare event. Solar and terrestrial effects of radio bursts and possible unifying causes are mentioned. 77 references. (M.J.T.)

16365 SOLAR PERTURBATIONS OF THE SPACE ENVIRONMENT. Henry J. Smith. 15p. (CONF-651-54)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964).

The different types of solar events which are significant in the study of the space environment are reviewed. (D.C.W.)

Atomic Physics

Refer also to abstracts 16442 and 17021.

16366 (AD-609177(Sect.A)) ION GENERATION RATE THEORY AND ANALYSIS OF EXPERIMENTAL CURRENT-VOLTAGE DATA. (General Motors Corp., Warren, Mich. Research Labs.). 35p.

The ion generation rate in a noble gas is computed from the energy loss of the fission fragments as they penetrate the gas adjacent to a fissioning uranium plate. A description of the digital computer program is given. The current-voltage characteristic for an ionization tube is then computed using the ion generation rate. A brief description of this computer program is also given. Finally, the in-pile experimental current-voltage characteristics obtained on a metal-ceramic ionization tube are compared with the results of the computations. The I-V curves computed with no adjustable parameters agreed well (±10%) with the experimental curves, and confirmed both the ion generation rate and ion transport models. (auth)

16367 (GA-5652) LHK—AN IBM 7044 CODE TO CALCULATE CROSS SECTIONS AND KERNELS FOR LIQUID PARA- AND ORTHO-HYDROGEN. Y. D. Naliboff (General Atomic, San Diego, Calif.). July 30, 1964. Contract NAS-3-4214. 16p. (NASA-CR-54227).

The code LHK, which calculates double-differential cross sections, total cross sections, and kernels for liquid para- and ortho-hydrogen, is described. The equations are presented, as they are used in the code; an over-all description of the code and comments about various subroutines are provided; the various approximations used, their effects, and some of the checks made are discussed; additions that may be made to the code are described; and the input instructions are given. (auth)

16368 (JINR-P-1911) STRUKTURA PROTONA I SVERKHTONKOE RASSCHEPLENIE UROVNEI ENERGII

VODORODA. (The Proton Structure and the Hyperfine Splitting of the Hydrogen Energy Levels). R. N. Faustov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1964. 14p. Dep.(mn).

The quasipotential approach in quantum field theory is used to calculate the hyperfine structure interval in hydrogen. The quasipotential equation for the system of two fermions is obtained. The corrections to the Fermi formula for the S-levels are calculated, taking into account the proton electromagnetic form factor. The theoretical and experimental values of the ground state hyperfine structure interval in hydrogen are compared. (auth)

16369 (NP-14702) KONVERSSIYA ORTOPOZITRONIYA V DISSOTSIIROVANNOM VODORODE. (Orthopositronium Conversion in Dissociated Hydrogen). B. G. Egiazarov and A. A. Sazykin (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. Dep.(mn).

A mean half life of ortho-positronium in hydrogen was studied at temperatures corresponding to partial or complete hydrogen dissociation. It is shown that the quenching process of ortho-positronium in atomic hydrogen by the conversion process is quite efficient. At the temperature of less than 0.3 ev, the mean life of ortho-positronium becomes identical to the mean life of para-positronium. With the rise of the temperature the lifetime of a new ortho-positronium component is somewhere between the lifetime of a free para-positronium and ortho-positronium. (R.V.J.)

16370 (UCRL-7943-T) N = 3 TRUNCATION WAVE FUNCTIONS AND ENERGIES FOR 18 MEMBERS OF THE HELIUM ISOELECTRONIC SEQUENCE. B. Curnutte, Jr. (Kansas State Univ., Manhattan) and J. E. Swain (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 1965. Contract W-7405-eng-48. 154p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The secular equation approach to the calculation of helium wave functions and energies is continued. The calculations were carried out for the third stage truncation of the infinite degree secular equation. Wave functions and energies for several states of 18 members of the helium isoelectronic sequence are presented. Included among the states presented are several for the doubly excited atom or ion. The results of the energy calculations for the 2^1S, 2^1P, 2^3P states of helium, although not as accurate as recent variational calculations, are in error approximately 0.2 ev. The magnitude of this discrepancy for these states increases with atomic number, but the relative accuracy improves. The results for the remainder of the singly-excited states are less accurate by comparison with variational calculations than are the results for the 2-singlet and triplet S and P states. The results for the doubly-excited states are in some cases more accurate than the best variational or perturbation calculations, and in some cases are the only results available. (auth)

16371 QUANTITATIVE CALCULATIONS OF DIRECT EXCITATION OF CHARACTERISTIC X-RAYS BY ELECTRONS IN THICK TARGETS. E. J. Suoninen (Univ. of Oulu, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 166, 1-16(1964).

A formula is derived for the amount of characteristic x radiation from direct excitation by electrons in a massive target. The formula is based on Makhov's description of electron penetration. Results of numerical applications to K radiation from copper, aluminum and graphite are given. The results agree well with Dolby's measurements on aluminum and various data on copper. (auth)

16372 ABSOLUTE CALIBRATION AND USE OF A SOFT X-RAY SOURCE OF CHARACTERISTIC CARBON RADIATION. A. J. Caruso and W. M. Neupert (Goddard Space Flight Center, Greenbelt, Md.). Appl. Opt., 4: 247-51(Feb. 1965).

A measurement of the absolute photon yield of characteristic carbon K radiation produced by direct electron bombardment of a target is described. The carbon K emission is produced by a simple and economical source. The radiation is detected with a commercially available proportional counter, using both commercially available windows and thinner windows made at the laboratory. A method for determining gas absorption efficiency of the counter and transmission of the counter window is described. The pulse height distributions obtained from the proportional counter varied in shape with target voltage indicating the presence of a bremsstrahlung continuum as well as characteristic K radiation. The continuum contribution was subtracted from the total counting rate to obtain the photon yield of characteristic K radiation as a function of target voltage. The results of this determination were used in the calibration of a grazing incidence grating spectrometer at 44 Å. (auth)

16373 CIRCULAR PHOTON POLARIZATION DETECTION BY PAIR PRODUCTION. H. Kolbenstvedt and H. Olsen (Inst. of Physics, NLHT, Trondheim, Norway). Arkiv Fys. Seminar Trondheim, No. 8, 1-11(1964).

The emission asymmetry in pair production by circularly polarized photons is calculated in the second-order Born approximation. The possibility for application of the effect for detection of photon circular polarization is discussed. (auth)

16374 A GENERALIZATION OF THE RASETTI AND SLATER METHODS FOR DETERMINING THE EIGENVALUES AND EIGENFUNCTIONS FOR A GIVEN ATOMIC FIELD. T. Tietz (Indiana Univ., Bloomington). Can. J. Phys., 43: 250-5(Feb. 1965).

The eigenvalues and eigenfunctions of electrons are given for a given atomic field. (auth)

16375 SOME LOW-ENERGY ATOMIC STOPPING CROSS SECTIONS. J. H. Ormrod, J. R. MacDonald, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 43: 275-84(Feb. 1965).

The electronic stopping cross sections for protons in aluminum are reported in the energy interval $10 < E < 70$ kev. Stopping cross sections below 150 kev in carbon targets for projectiles with $13 \leq Z \leq 19$, and in aluminum targets for $Z \leq 11$ are reported also. The results are compared with theory and show reasonable agreement. The previously reported periodic dependence of S_ϵ on the atomic number of the projectile is also evident in the present results. (auth)

16376 ON DISTORTED ELECTRONS IN AVALANCHES ESPECIALLY IN OXYGEN AND AIR BY FORMATION AND DECAY OF NEGATIVE IONS (O^-). L. Frommhold (Universitat, Hamburg). Fortschr. Physik, 12: 597-642(1964). (In German)

It is demonstrated that negative ions formed by electrons drifting through a gas may commonly not be considered as being stable, but electron detachment must be taken into account. This is concluded from investigating electron current pulses of avalanches which exhibit strong currents of delayed (detached) electrons in oxygen and air, but not in hydrogen, nitrogen, and certain other electropositive gases. It is shown that this assumption allows an explanation of the observed current pulse shapes. An attachment coefficient η as a function of E/p (= ratio of field strength to pressure) is determined which arises from the dissociative attachment process, $e + O_2 \rightarrow O^- + O$. A detachment frequency $1/\tau$ versus E/p is obtained which arises from de-ionizing collisions of the same ion O^-, which has been sufficiently energized by the electric field, $O^- + O_2 \rightarrow e + O + O_2$, thus completing the evidence for the above conclusion. (In air a N_2 molecule may act as well as O_2 as colliding particle.) In addition, values of the electron ionization coefficient α/p and of the electron drift velocity v_- are determined in oxygen ($35 < E/p < 120$ v/cm × torr) and air ($35 < E/p < 80$). The "electrical method" was used. The initial photoelectron pulse was released by the light of a high intensity spark of 5×10^{-9} sec radiation pulse duration; the luminous tail was suppressed by a Kerr cell shutter. (auth)

16377 X-RAY YIELD AND LINE/BACKGROUND RATIOS FOR ELECTRON EXCITATION. L. S. Birks,

R. E. Seebold, B. K. Grant, and J. S. Grosso (Naval Research Lab., Washington, D. C.). J. Appl. Phys., 36: 699-702(Mar. 1965).

The x-ray yield in photons/Sr/electron was measured for the Kα lines of Ti, Cr, Mn, Fe, Cu, Zn, Ge, Zr, and the Lα lines of Ta and Au. Incident electron energy was varied from 11 to 38 kev, and for some elements the take-off angle for emerging x rays was varied from 6 to 45°. Theoretical yield values calculated after the method of Metchnik and Tomlin showed an average deviation of about 30% from the measured values, a very satisfactory agreement. Line/background ratios were also measured for the same elements and conditions. Normalization to the natural x-ray line breadths gave ratios between 100/1 and 26,000/1 depending on the element and experimental conditions. Line/background ratios are consistently larger at low take-off angles indicating that the characteristic radiation must be generated relatively closer to the surface than the continuum of the same wavelength. (auth)

16378 DEACTIVATION OF NEON METASTABLES BY HYDROGENIC IMPURITIES. Thomas Marshall (Columbia Univ., New York). J. Appl. Phys., 36: 712-17(Mar. 1965).

Measurements are reported of the total cross section for deactivation of neon $^3P_2$ and $^3P_0(2p^53s)$ metastables by inelastic collisions with H_2, D_2, CH_4, and NH_3. Observations were conducted by applying the methods of resonance radiation absorption and microwave diagnostics to the afterglow plasma following a weak pulsed discharge in a neon-hydrogenic impurity mixture. The cross section for $^3P_2$ deactivation by H_2 was found to increase from 0.7×10^{-18} cm^2 at 300°K to 2.5×10^{-18} cm^2 at 650°K. The cross section for ionization of H_2 by $Ne^{*3}P_2$ collision was found to represent only a fraction of the above. The reaction which dissociates H_2 and partly converts the metastable energy into Hα(6563 Å) light has been observed in H_2, D_2, CH_4, and NH_3 and may represent a significant contribution to the total deactivation in each case. No Hα light was produced as a result of the destruction of a helium $^3S_1$ metastable by collision with H_2. (auth)

16379 CESIUM PARTIAL PRESSURE OVER A Cs_3Sb PHOTOCATHODE. Jay Burns (Univ. of Chicago). J. Appl. Phys., 36: 856-7(Mar. 1965).

The partial pressure of Cs over a Cs-Sb photocathode was determined, using the gradual loss in photosensitivity of a photocathode placed in a cesium-free, ultravacuum environment. (D.C.W.)

16380 EFFECT OF SCATTERING ON CHARGE TRANSFER EFFICIENCY MEASUREMENTS: REPLY TO PETERSON'S LETTER. P. Mahadevan and R. Marriott (General Dynamics/Astronautics, San Diego, Calif.). J. Appl. Phys., 36: 863-4(Mar. 1965).

The observed discrepancy in energy transfer between ions and neutron atoms bombarding surfaces was attributed by Peterson to elastic scattering of the ions and neutral atoms outside the solid angles subtended by the detector at the interaction region. The magnitude is first estimated of the scattered ion and neutral currents that would be required to give the observed discrepancy on the basis of Peterson's assumption that the total scattering of the fast ions (elastic and inelastic contributions) outside the average geometric half angle subtended at the interaction region by the detector equals the elastic scattering of the fast neutral atoms. The scattered currents are then estimated on the basis of Firsov's more reasonable assumption that the elastic scattering of fast ions and neutral atoms colliding with atoms in the kinetic energy range of interest here are effectively the same. Finally, a re-examination of the geometry of the system used for these measurements indicates that both of the above estimates lead to scattered currents much too large to have been lost from the beam unnoticed. (auth)

16381 NUCLEAR MAGNETIC DIPOLE-DIPOLE RELAXATION IN MOLECULES WITH INTERNAL MOTION. D. E. Woessner (Socony Mobil Oil Co., Inc., Dallas). J. Chem. Phys., 42: 1855-9(Mar. 15, 1965).

The nuclear magnetic dipole-dipole relaxation for nuclei of spin $^1/_2$ was calculated for a model in which the length, as well as the orientation, of the internuclear separation vector varies as a result of internal molecular motion. In liquid molecules the internal motion increased the relaxation times. The effect of internal motion was to split the average of the inverse sixth power of internuclear separation into more terms, and most of these terms had shorter correlation times than for a system of rigid molecules with the same distribution of internuclear separation values. (auth)

16382 SCATTERING FROM FLUIDS OF NONSPHERICAL MOLECULES. I. X RAYS AND NEUTRONS. William A. Steele (Universite Libre, Brussels) and R. Pecora. J. Chem. Phys., 42: 1863-71(Mar. 15, 1965).

The general theory of the statistical mechanics of nonspherical molecules was applied to the problem of the scattering of x rays and slow neutrons from a fluid composed of nonspherical molecules. Expressions for the differential scattering cross sections were derived for the cases of both elastic and inelastic scattering. General properties of the time-dependent correlation functions are discussed, and a short-time approximation is given and applied to the calculation of the inelastic neutron scattering cross section. (auth)

16383 SIMPLE ANALYTICAL FORMULA FOR THE PHASE SHIFTS OF ELECTRON SCATTERING BY GIVEN ATOMIC FIELDS. T. Tietz (Indiana Univ., Bloomington). J. Chem. Phys., 42: 2251-3(Mar. 15, 1965).

An analytical formula is given for phase shifts of electron scattering by a given atomic field. Phase shifts for argon at 40, 80, and 100 kev are given. (M.C.G.)

16384 MATHEMATICAL METHODS FOR EVALUATING THREE-BODY INTERACTIONS BETWEEN CLOSED-SHELL ATOMS OR IONS. Samson Zimering (Battelle Memorial Inst., Geneva). J. Math. Phys. (N. Y.), 6: 336-47(Mar. 1965).

The mathematical methods involved in the evaluation of three-body interactions between rare-gas atoms or alkali-halide ions with Gaussian type electron wavefunctions are outlined in first and second orders of perturbation theory. These methods are of general applicability for the analysis of many-center coulombic and exchange integrals occurring in problems of atomic and solid-state physics in which Gaussian functions can be used as a basis. (auth)

16385 THE EXCLUSION PRINCIPLE AND THE SPIN. B. L. van der Waerden. Magy. Fiz. Folyoirat, 12: 453-89 (1964). (In Hungarian)

A review on the exclusion principle and spin is presented, with consideration of the Zeeman effect, statistical thermodynamics, the spinning electron in general relativity theory, spinor analysis, Weil's equation, and nonconservation of parity. (D.C.W.)

16386 NEW NONQUADRUPOLE TRANSITION IN THE L-SPECTRUM OF BISMUTH-83. H.-D. Bauer (Technische Universitat, Dresden). Naturwissenschaften, 51: 632(1964). (In German)

The L spectrum of bismuth was measured using a curved mica crystal spectrograph. A faint but distinct line corresponding to the nonquadrupole transition $L_{II}N_V$ was observed near the strong line $L\gamma_1$(λ = 811.48 x. u.). The wavelength of the line was measured to be 809.9 X. U. The observed values of ν/R were in fair agreement with calculated values. (D.C.W.)

16387 COMPOUND-ATOM STATES FOR TWO-ELECTRON SYSTEMS. T. F. O'Malley and S. Geltman (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 137: A1344-52(Mar. 1, 1965).

The energies of the lowest He-like compound-atom or resonance states lying below the n = 2 hydrogenic level are evaluated variationally for He and H^-. The definition of such states given by Feshbach as eigenvalues of the Hamil-

tonian with the open channel projected out is used, together with the modification required by the Pauli principle. The trial wave function uses a Legendre expansion in the relative angle and a sum of exponentials in the radial coordinates, with appropriate angular factors to obtain the desired symmetry, parity, and orbital-angular-momentum eigenvalues associated with the $^{1,3}S^e$ and $^{1,3}P^0$ states. The results are approximations to the actual physical resonances in that the shift and finite width caused by coupling to the neighboring continuum are not included. It appears, however, that the actual shifts are small, so that the positions of these compound-atom states are believed to give a close indication of where the physical resonances may be expected to occur. The results for He and H^- are compared in detail with the calculations of resonances in e-H and e-He^+ elastic scattering and with the observation of these states by ultraviolet photon absorption in He (where they are called autoionizing levels) and by inelastic scattering of electrons from He. (auth)

16388 LINE PROFILES IN THE FAR-UV ABSORPTION SPECTRA OF THE RARE GASES. U. Fano and J. W. Cooper (National Bureau of Standards, Washington, D. C.). Phys. Rev., 137: A1364-79(Mar. 1, 1965).

The line profiles of a dozen series of widely different appearance, observed recently in the rare-gas optical absorption spectra between 20 and 100 ev, are analyzed by adapting and extending previously developed theory. Theory characterizes each profile by its linewidth, q index, and correlation coefficient p and relates these parameters to matrix elements of the energy and of the electric dipole moment. Because the profiles result from interference effects, the signs of these matrix elements are highly relevant. Crude estimates of such, hitherto hardly accessible, matrix elements are obtained from experimental evidence and from atomic theory, and are intercompared and found to be in general agreement. Similarities and differences among the line profiles are thereby tentatively explained. The connection of Rydberg series and absorption edges is discussed and the occurrence of downward jumps at some edges is explained. This exploratory investigation demonstrates how one can treat experimental data, and it surveys the kind and volume of information on the dynamics of highly and multiply excited atoms made accessible by recent experimental techniques. (auth)

16389 MEASUREMENT OF THE L ABSORPTION SPECTRA OF XENON. Takeshi Watanabe (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 137: A1380-2(Mar. 1, 1965).

The x-ray L_I, L_{II}, and L_{III} absorption spectra of gaseous xenon were measured with a two-crystal x-ray spectrometer. Absolute values of the absorption coefficients were determined on both sides of each edge. It was found that the L_{II} and L_{III} spectra have similar structural characteristics at the edge, each having a resonance peak, while the absorption coefficient at the L_I edge increases smoothly and does not exhibit the absorption peak. The jump ratios were found to be 1.12, 1.38, and 2.60 for the L_I, L_{II}, and L_{III} edges, respectively. An estimate was made of the oscillator strengths for the bound-bound transitions. (auth)

16390 ATOMIC ABSORPTION CROSS SECTION OF LITHIUM VAPOR BETWEEN 2300 AND 1150 Å. R. D. Hudson and V. L. Carter (Aerospace Corp., El Segundo, Calif.). Phys. Rev., 137: A1648-50(Mar. 15, 1965).

The continuous atomic absorption cross section of lithium vapor was measured using photoelectric techniques from the $2s^2S \rightarrow np^2P^0$ series limit at 2300 to 1150 Å. The bandwidth of the monochromator was 0.75 Å and values of the cross section were obtained at 2-Å intervals. The best value for the atomic absorption cross section at the series limit was 1.54 ± 0.23 Mb. The shape of the curve near the series limit is in close agreement with some recent theoretical predictions. There is an apparent disagreement with recent experimental results. (auth)

16391 EXCITATION OF THE HYDROGEN MOLECULAR ION BY ELECTRON IMPACT. Joseph Callaway and Raymond K. M. Chow (Univ. of California, Riverside). Phys. Rev., 137: A1662-4(Mar. 15, 1965).

The cross section for the excitation of the lowest electronic excited state of the hydrogen molecular ion, H_2^+, by electron impact was computed. The calculation employs the Born approximation and includes exchange effects according to the procedure developed by Bell and Moiseiwitsch. In contrast to the results of a previous calculation, the inclusion of exchange produces only a small increase in the cross section near threshold. (auth)

16392 ATOMIC READJUSTMENT TO VACANCIES IN THE K AND L SHELLS OF ARGON. Thomas A. Carlson and Manfred O. Krause (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A1655-62(Mar. 15, 1965). (ORNL-P-666).

The relative abundances were measured for the argon ions that are formed as the result of atomic readjustment to vacancies in the K and L shells of argon. Initial vacancies were produced by x rays, and the ions were analyzed with a magnetic spectrometer, such as that used by Snell and Pleasonton in their work on radioactive rare gases. A new source volume for extracting the ions was used and is described. Measurements were made of charge spectra resulting from x rays of the approximate energies 17.5, 4.5, 1.5, and 1.0 kev. The spectra obtained with x-ray energies above the K edge of argon bore a close resemblance to that obtained from $^{37}Ar \rightarrow_{EC} {}^{37}Cl$. For comparison with the experimental results each of the charge spectra was computed from knowledge of radiative and Auger transition rates. In addition, calculations were made of the electron shake-off that arises from sudden changes in the effective charge. In general, the agreement between the calculated and the experimental values is good, although there is some evidence that there may be other sources of additional ionization. (auth)

16393 EFFECT OF LONG-RANGE FINAL-STATE FORCES ON THE NEGATIVE-ION PHOTODETACHMENT CROSS SECTION NEAR THRESHOLD. Thomas F. O'Malley (Joint Inst. for Lab. Astrophysics, Boulder, Colo. and Defense Research Corp., Santa Barbara, Calif.). Phys. Rev., 137: A1668-72(Mar. 15, 1965).

The accepted threshold law for the photodetachment cross section may be written as $\sigma = \text{const}\ k^{2l_0+1}[1 + O(k^2)]$, where l_0 is the lowest value of the angular momentum allowed the electron and k is its momentum. This law presupposes that the forces in the final state are of finite range. The effect of the long-range (r^{-3} and r^{-4}) multipole forces between the residual neutral atom and the outgoing electron on the threshold behavior is investigated. It is found that the behavior of the total cross section is changed to $\sigma = \text{const}\ k^{2l_0+1}[1 + C\,k^2 \ln k + O(k^2)]$, where the coefficient C is determined entirely by the long-range force. The effect of an r^{-2} potential is also found. In this case, even the leading term is altered from the standard form. (auth)

16394 QUANTUM MECHANICAL POTENTIAL ENERGY CURVES FOR THE $^1\Pi_u$ AND $^3\Pi_u$ STATES OF He_2 AND THE $^1\Pi_g$, AND $^3\Pi_g$ STATES OF H_2. J. C. Browne (Queens Univ., Belfast). Phys. Rev., 138: A9-11(Apr. 5, 1965).

There are reported calculated curves for the $^1\pi_u$ and $^3\pi_u$ states of He_2 for the $^1\pi_g$ and $^3\pi_g$ states of H_2. In each case the potential curve shows a pronounced maximum before descending into a bound state. These maxima are shown to result from interactions of potential curves originating from a normal atom and a second quantum excited atom with curves which originate in a normal atom plus a third quantum excited atom. The computed maxima are $^1\pi_u(He_2) \approx 0.5$ ev, $R = 3.5\ A_0$, $^3\pi_u(He_2) \approx 0.6$ ev, $R = 3.0\ A_0$, $^1\pi_g(He_2) \approx 0.43$ ev, $R = 4.0\ A_0$, and $^3\pi_g(He) \approx 0.57$ ev, $R = 4.0\ A_0$. These maxima were predicted earlier by Mulliken on semitheoretical grounds. The wave function used for each calculation was a three term function of the generalized valence-bond type. All used Slater-type orbitals for a basis set. (auth)

16395 ABSOLUTE TOTAL ELECTRON–HELIUM-ATOM SCATTERING CROSS SECTIONS FOR LOW ELEC-

TRON ENERGIES. D. E. Golden and H. W. Bandel (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 138: A14-21(Apr. 5, 1965).

The Ramsauer technique was used to measure the absolute total electron–helium-atom scattering cross section as a function of electron energy from 0.30 to 28 ev with an estimated probable error of ±3%. No fine structure was observed at the lower electron energies studied. The variation of the cross section with energy for energies less than 3 ev is in reasonable agreement with the modified effective-range formula given by O'Malley, using a scattering length of $1.15a_0$. The cross section first increases with decreasing electron energy from 2.2 $Å^2$ at 28.0 ev to a maximum of 5.6 $Å^2$ at about 1.2 ev and then decreases to 5.4 $Å^2$ at 0.300 ev. The cross section was found to decrease sharply with increasing energy at about 0.5 ev below the first excitation energy. This resonance, predicted by Baranger and Gerjuoy and originally observed by Schulz, first decreases with increasing energy to a minimum of about 10% below the background at 19.285 ± 0.025 ev and then increases to a gentle maximum of about 3% above the background at 19.65 ± 0.05 ev. The resolution of this resonance as well as the 10% decrease in the cross section at the minimum is determined by the half-width of the electron beam at this energy which is about 0.1 ev. (auth)

16396 OBSERVATION OF LEVEL CROSSING IN H, n = 2. R. T. Robiscoe (Univ. of Chicago). Phys. Rev., 138: A22-34(Apr. 5, 1965).

The crossing of the atomic hydrogen levels $\beta_B(2S_{½}, m_J = -½, m_I = -½)$ and $e_B(2P_{½}, m_J = +½, m_I = -½)$ near 605 G was observed. A new atomic-beam method is used. H atoms are excited to the metastable 2S state by electron bombardment. The $2S(m_J = -½)$ state is quenched in the bombardment region. The $2S(m_J = +½)$ beam passes through a zero-field region where ⅓ of it is converted to the single hyperfine level β_B. The β_B atoms enter a uniform magnetic field parallel to the beam. With no externally applied electric field, 92% of them reach the detector. When an electrostatic field of about 0.7 v/cm is applied perpendicular to the beam, the β_B atoms are strongly quenched near the $\beta_B - e_B$ crossing point. Observed quenching agrees with the Bethe-Lamb theory of the 2S lifetime in external fields. The magnetic field was measured by the nuclear magnetic resonance frequency of protons in water. Natural asymmetry and minor experimental corrections reduce the observed center of the $\beta_B - e_B$ quenching resonance by 1 part in 10^4. The corrected $\beta_B - e_B$ crossing occurs at 2577.57 ± 0.25 kc proton nmr in water. From this, the Lamb shift $\mathscr{S}$ in H, n = 2, is calculated. With a diamagnetic shielding correction, and the accurately known 2S hyperfine interval, $\mathscr{S}$ = 1058.07 ± 0.10 Mc. This disagrees with $\mathscr{S}$ = 1057.77 ± 0.10 Mc from the Lamb experiments. (auth)

16397 EFFECT OF CHANNELING OF LOW-ENERGY PROTONS OF THE CHARACTERISTIC X-RAY PRODUCTION IN SINGLE CRYSTALS. Werner Brandt, J. M. Khan, D. L. Potter, R. D. Worley, and Harold P. Smith, Jr. (New York Univ., New York). Phys. Rev. Letters, 14: 42-4 (Jan. 11, 1965).

The yields of K and L x rays from Al and Cu, respectively, under exposure to proton beams were measured as a function of the beam incidence angle around 0°. A pronounced dip in the yield was observed, centered about 0°; the widths of the dips were in agreement with a formula obtained for the critical angle. It was concluded that the characteristic x-ray production by protons in single crystals is strongly dependent on the crystal symmetry. (D.C.W.)

16398 THEORY OF MULTIPHOTON IONIZATION. Albert Gold and H. Barry Bebb (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 13: 60-3(Jan. 18, 1965).

A theory of the N-photon photoionization of transparent gases is presented, explicitly treating systems with N as high as 14. The apparent thresholds for optical ionization of Ar, He, Kr, Ne, and Xe are calculated. (D.C.W.)

16399 STATISTICAL MODEL OF ATOMS WITH CORRELATION AND ANGULAR MOMENTUM. Ashok Jain (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 677-84 (Nov. 1964).

The statistical model of atoms with a non-zero total angular momentum is extended, within the semi-classical frame work, to include the correlation energy of the electron gas. The equations for the model are derived by means of a variational principle and are solved approximately by a perturbation method. As an application of the model, the approximate solution is used to compute values of the orbital magnetic hyperfine structure parameter for five different elements. Also, the previously reported values of the same quantity for the case of no-correlation are recalculated by using revised values of the TF and TFD functions. The results are presented graphically. The effect of correlation on the orbital magnetic hyperfine structure is shown to be quite large. (auth)

16400 IONIZATION OF ELECTRON TRAPS IN ELECTROLUMINESCENT PHOSPHORS OF THE TYPE Zn(S:Se):Cu. Sumitada Asano and Yasuhiro Nakao (Okayama Univ., Japan). Rept. Res. Lab. Surface Sci., Fac. Sci., Okayama Univ., 2: No. 3, 71-81(Nov. 1963). (In French)

The probabilities of field emission and thermal excitation of the electrons in traps (or donors) with Coulomb-type potential are calculated. Calculations are made on the ionization of traps and luminescence centers in the Schottky layer of electroluminescent phosphors. It is concluded that most of the traps in the Schottky layer of the electroluminescent phosphor operating under ordinary conditions are ionized at the instant when the applied a-c field takes the maximum value and that the temperature change in voltage dependence of luminescence intensity is caused by the change in mobility of the free electrons traveling through the Schottky layer. (auth)

16401 ELECTRON SCATTERING WITHOUT ATOMIC OR NUCLEAR EXCITATION. J. W. Motz, Haakon Olsen, and H. W. Koch (National Bureau of Standards, Washington, D. C.). Rev. Mod. Phys., 36: 881-928(Oct. 1964).

Single electron scattering by atoms with no nuclear or atomic excitation is studied. Radiative effects are neglected. In the absence of exact information concerning the atomic and nuclear structures and scattering potentials, various approximations are used to estimate the behavior of the scattering distributions. (T.F.H.)

16402 SYMMETRIC EULER-ANGLE DECOMPOSITION OF THE TWO-ELECTRON FIXED-NUCLEUS PROBLEM. A. K. Bhatia and A. Temkin (Goddard Space Flight Center, Greenbelt, Md.). Rev. Mod. Phys., 36: 1050-64 (Oct. 1964).

A set of Euler angles is chosen for analysis of the two-electron wave functions in the case in which the nucleus is fixed. The angles are chosen in such a way that the third angle depends only on the unit vectors of the problem, and is symmetric with respect to the position vectors of the two electrons. The analysis is first cast in the framework of the problem of two identical particles in the field of an infinitely massive nucleus, and the case of electrons in the field of a finite-mass nucleus is then derived as a generalization of this original problem. The angular momentum, parity, exchange, kinetic energy, total wave functions, reduced or radial equations, and associated scattering problem are studied. (T.F.H.)

16403 DISPERSION OF THE SURFACE PLASMA LOSS IN Al. P. Schmueser (Universitat, Hamburg). Solid State Commun., 2: 41-3(Feb. 1964).

Characteristic energy loss experiments with 40-kev electrons on very thin aluminum films showed a strong variation of surface loss position with scattering angle. The main character of this dispersion and the thickness dependency of the loss position were in agreement with theoretical predictions. (auth)

16404 ON THE BEHAVIOR OF NUCLEAR ENERGY LOSSES OF ELECTRONS IN ALKALI HALIDES. M. Creuzburg and H. Raether (Universitat, Hamburg). Solid State Commun., 2: 175-7(June 1964).

The energy loss spectra of 50-kev electrons passing through alkali halides consist of a steplike broad background with superposed characteristic maxima. All measured losses showed an angular distribution of their intensity. Some losses were so sharp that measurement of a dispersion of less than 1 ev was possible. The inelastic mean free path length was very long, and amounted to about 5×10^4 Å for the 13.6-ev loss in LiF. (auth)

16405 SOME ANGULAR REGULARITIES IN THE SCATTERING OF SLOW ALKALI METAL IONS FROM A MOLYBDENUM SURFACE. V. I. Veksler (Tashkent State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 1767-73(Feb. 1965). Translated from Fiz. Tverd. Tela, 6: 2229-37(Aug. 1964).

The maximum energy W_m of K^+, Rb^+, and Cs^+ ions scattered from an incandescent molybdenum surface (T = 1600-1800°K) as a function of the initial ion energy (20 to 260 ev) was studied for various scattering angles. The effective mass of the lattice atoms from which the scattering took place, calculated on the basis of the results plotted as a function of kinetic energy transferred by the ion to the lattice atoms, was independent of the scattering angle. The dependence of the effective mass on the initial energy of K^+ ions was subject to the same regularity as was earlier observed for Rb^+ and Cs^+. An interpretation is proposed for the results found. It is shown that they cannot be explained as effects connected with the transfer of momentum in the directions of atomic closest packing in the lattice, or by multiple scattering of ions on different atoms of the target. The angular dependence of the yield of scattered ions was also investigated. (auth)

16406 INELASTIC SCATTERING OF ELECTRONS IN SOLIDS WITH THE PRIMARY BEAM AT OBLIQUE INCIDENCE. I. M. Bronshtein and S. S. Denisov (Leningrad State Pedagogical Inst.). Soviet Phys.-Solid State (English Transl.), 6: 2106-10(Mar. 1965). Translated from Fiz. Tverd. Tela, 6: 2644-9(Sept. 1964).

The dependence of the relative coefficient of inelastic scattering and effective escape depth of the inelastically scattered electrons on the energy and angle of incidence of the primary electrons was investigated in Be, Al, Si, Ti, Ni, and Pb in the energy interval from 0.1 to 5 kev and for angles of incidence $\leq 60°$. (auth)

16407 THE POSSIBLE USE OF RESONANCE CAPTURE OF NEUTRONS FOR INVESTIGATING THE VIBRATIONAL SPECTRUM OF IMPURITY ATOMS IN CRYSTALS. S. V. Maleev (Ioffe Inst. of Physics and Tech., Lenningrad). Soviet Phys.-Solid State (English Transl.), 6: 2162-6(Mar. 1965). Translated from Fiz. Tverd. Tela, 6: 2717-22 (Sept. 1964).

The addition of a small quantity of an isotope consisting of nuclei capable of resonance capture of neutrons in the energy region below 1 ev transforms a material from a poor neutron absorber into a good absorber. Absorption takes place almost completely by the impurity nuclei. Since the resonance energy lies in a region close to the thermal region, it is possible to determine the vibrational density of the impurity nucleus $g(\omega)$ from the energy dependence of the absorption cross section. The problem of the accuracy of such a determination is discussed and it is shown that an accuracy of the order of 10% may be reached in the high-frequency region. (auth)

16408 A MEASUREMENT OF LIFETIMES FOR THE EXCITED STATES OF HYDROGEN ATOMS. V. A. Ankudinov, S. V. Bobashov, and E. P. Andreev (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 40-9(Jan. 1965). (In Russian)

A method is described to determine the lifetimes of atoms in excited states by observing the growth of the intensity of light emitted by a beam of fast atomic particles as it passes along a gaseous target. Using this method the lifetimes of hydrogen atoms in the states with n = 3, 4, 5 produced in the process of dissociation of H_2^+ ions (energy range 10–30 kev) in He were measured. The values obtained for these lifetimes are in good agreement with those calculated by quantum mechanics for the statistical population of the fine structure sublevels of the hydrogen atom. (auth)

16409 THEORY OF BREMSSTRAHLUNG OF SLOW ELECTRONS ON AN ATOM. V. Kasyanov and A. Starostin (Inst. of Power Engineering, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 295-302(Jan. 1965). (In Russian)

Bremsstrahlung of slow electrons on neutral systems is considered. A diagram technique is developed which makes it possible to take into account radiation from the atom as well as that from the impinging particle. For a weak dependence of the elastic scattering cross section on energy the results are an extension of previously obtained results. The intensity of infrared radiation from a gaseous plasma is compared with the experimental results. (auth)

16410 COHERENCE RELAXATION OF EXCITED ATOMS IN COLLISIONS. M. I. Dyakonov and V. I. Perel (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 345-52(Jan. 1965). (In Russian)

Relaxation of the nondiagonal density matrix of excited gas atoms due to collisions with normal atoms is considered. The relaxation term is diagonalized by changing to a different representation. The diagonal elements γ_1 and γ_2 have the simple meaning of inverse relaxation times for circular and plane polarization respectively. The numerical values of γ_1 and γ_2 are obtained for the most interesting case when the total angular momenta of the ground and excited states are respectively zero and unity. (auth)

16411 IMPROVEMENT OF THE VACUUM IN A CHARGE EXCHANGE CHAMBER IN THE PROXIMITY OF THE SUPERSONIC GAS JET. F. I. Busol, V. B. Yuferov, and E. I. Skibenko (Inst. of Physics and Tech., Khar'kov). Zh. Tekhn. Fiz., 34: 2156-9(Dec. 1964). (In Russian)

In earlier studies devoted to investigation of CO_2, Ar, and N_2 jets as targets for charge exchange, it was found that in the proximity of an optimum density supersonic gas jet one can obtain and maintain a vacuum of only about 5×10^{-3} Newton/m^2; yet under the given experimental conditions, where the target should be as close as possible to the working region, a vacuum of 10^{-6} to 10^{-7} N/m^2 is required. Accordingly, it was essential to improve the vacuum in the proximity of the gas jet. Analysis of the gas flow conditions (turbulent with near isotropic velocity distribution at the nozzle outlet) led to development of the device described. The arrangement is diagramed. The tests were carried out on the setup used in the studies. The vacuum was measured by means of an LM-2 ionization gage located in a blind branch off the charge exchange chamber at a distance of 150 mm from the nozzle. The results of test runs with different shielding arrangements and then with different heights of the shielding tube are presented in the form of curves. The tests were made only with argon and carbon dioxide. The test results indicate that the vacuum in the vicinity of the target jet in a charge exchange chamber can be substantially enhanced by the simple device described, which effectively simplifies the design of the vacuum-separation components of the chamber installation. (ATD)

16412 USE OF THE EFFECT OF POSITIVE SURFACE IONIZATION FOR INVESTIGATING CATHODE SPUTTERING OF METALS. E. F. Chaikovskii and G. V. Ptitsyn (All-Union Scientific-Research Inst. of Monocrystals, Khar'kov). Zh. Tekhn. Fiz., 34: 2194-6(Dec. 1964). (In Russian)

One of the experimental problems encountered in studying cathode sputtering is that of obtaining ion beams of different intensity, but in each case monoenergetic and incident at a definite angle. To obtain the requisite beams there was used the phenomenon of positive surface ionization. The positive potassium ions thus produced were employed to investigate sputtering of platinum and nickel. The measurements were carried out by means of equipment previously used to study positive surface ionization. The emitter and collector were

made of platinum and nickel ribbon and measured 0.002 × 0.4 × 1.25 cm. The spacing between them was 0.03 to 0.04 cm. A potential of from 100 to 500 v was maintained between the emitter and collector. In preliminary measurements there was determined the dependence of the sputtering coefficient (yield in terms of atoms per ion) on the density of the ion beam; it was found that this dependence is nil, which indicates that the preheated, bombarded surfaces were clean. Then there were obtained the ion energy dependences of the sputtering coefficient. The results are shown. It is evident that in the investigated energy range (100 to 500 v) the dependences are linear. (ATD)

16413 SYSTEMATIC DEVIATIONS IN THE K- AND L-SHELL IONIZATION CROSS SECTIONS. M. C. Joshi and B. V. Thosar (Tata Inst. of Fundamental Research, Bombay). p. 152-8 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Previous experiments and Born-approximation predictions on the cross sections for K- and L-shell ionization by protons, alphas, and heavy ions are reviewed. Graphs are given of the variations of atomic number of the target with deviation of K-ionization cross section, L x-ray production cross section for 441-kev protons, and deviation of L-ionization cross section (M.J.T.)

16414 CRYSTAL STRUCTURE STUDIES BY NEUTRON DIFFRACTION. R. Chidambaram (Atomic Energy Establishment, Trombay, India). p.512-29 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Situations in which neutron diffraction is superior to x-ray diffraction for crystal-structure studies are illustrated. Work in automation of single crystal neutron diffraction studies is reviewed. Maximal utilization of time in neutron diffraction intensity data recording is discussed. Spectroscopic methods of determining H positions in crystals by infrared and Raman spectroscopy and proton magnetic resonance are described. X-ray and neutron diffraction methods for determining H positions are considered, and neutron diffraction data on H bonds are summarized. 47 references. (M.J.T.)

16415 MAGNETIC INELASTIC SCATTERING OF NEUTRONS FROM A FERROMAGNET. R. Subramaniam (Atomic Energy Establishment, Trombay, India) and G. A. Kharadze. p.540-2 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A theoretical study is reported of the line broadening in inelastic scattering of an unpolarized thermal-neutron beam by a ferromagnetic crystal consisting of identical atoms whose spins are coupled by the Heisenberg exchange interaction. The expression for the differential cross section for the magnetic scattering of neutrons by a crystal in which the orbital current is quenched by the intercrystalline electric field is given. A decoupling approximation is applied at the second stage to the equation of motion of the Green function; the approximation is valid only at low temperatures. Spectral behavior at low temperature is discussed. (M.J.T.)

16416 ATOMIC MOTIONS IN LIQUID ARGON. B. A. Dasannacharya and K. R. Rao (Atomic Energy Establishment, Trombay, India). p.549-55 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The scattering of slow neutrons in liquid argon was used to investigate atomic motions and to determine the diffusion mechanism. (C.E.S.)

16417 ATOMIC LIFETIMES IN NEON I. Jules Z. Klose (National Bureau of Standards, Washington, D. C.). 17p. (CONF-452-74)

From American Physical Society, Washington, D. C., Apr. 1964.

The mean lives of several excited states in neon I were determined, using a delayed-coincidence technique. The results were compared with other determinations. (D.C.W.)

16418 ELECTRON EMISSION PRODUCED BY GIANT PULSE LASER. J. F. Ready (Honeywell Research Center, Hopkins, Minn.). 15p. (CONF-640606-13)

From American Physical Society Summer Meeting, Denver.

The mechanism of electron emission from metallic surfaces under exposure to laser beams was investigated, using a Q-switched ruby laser at laser power densities of 10 to 20 Mw/cm^2. Measurements were made for Pt, W, and thoriated W surfaces. Analyses of the data indicate that the emission is thermal and is produced by surface heating and ordinary thermionic emission described by the Richardson equation. (D.C.W.)

16419 ION BEAM EXCITATION EFFECTS ON THE SINGLE CHARGE TRANSFER BETWEEN ARGON AND NITROGEN. Robert C. Amme and Howard C. Hayden (Univ. of Denver). 20p. (CONF-641016-1)

From 17th Annual Gaseous Electronics Conference, Atlantic City.

Single charge transfer cross sections for N_2^+ in Ar and Ar^+ in molecular N and Ar were measured as functions of ion energy and of ion source electron energy. Ion energies studied were in the range of 50 to 1000 ev. The ion source electron energy was varied from 16 to 24 ev for the N_2^+ ions, and 16 to 40 ev for Ar^+. For the $Ar^+ + N_2$ case, the cross section appeared to be non-resonant and was insensitive to ionizing electron energy. The slightly endothermic charge transfer for the $N_2^+ + Ar$ case also appeared to be nonresonant, but was measurably influenced by ion source electron energy. This result is attributed to the presence of long-lived excited states of N_2^+, reported earlier. Evidence is presented to show that the $(N_2^+)^*$ ions exhibit near-resonant behavior in charge transfer with argon atoms. This suggests that the effect is due to an increased population of vibrational states v = 1, 2 at higher electron energies. (auth)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

Refer also to abstracts 16326, 16362, 16567, 16595, 16743, and 16852.

16420 COSMIC NOISE ABSORPTION EVENTS AT GEOMAGNETICALLY CONJUGATE STATIONS. C. G. Little, E. R. Schiffmacher, H. J. A. Chivers, and K. W. Sullivan (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 639-48(Feb. 1, 1965).

A two-month program of observations of cosmic radio noise absorption in geomagnetically conjugate areas is described. A closely spaced network of stations in the conjugate area in one hemisphere revealed that the position of maximum correlation changed from event to event and during events. There were, moreover, very rare occasions in which events were exclusively confined to one hemisphere. For the conjugate events, the magnitude of the absorption was greater in the winter hemisphere than in the summer hemisphere, even under similar solar illumination conditions. The conjugate area (defined by the 0.5 correlation coefficient contour) in general appeared to be that of a circle of radius about 700 km, but for individual events the extent was clearly more limited. The movement of the conjugate area is believed to be due to the changing latitude of the point at which exospheric particles are injected into the earth's atmosphere. It is suggested that the greater absorption in the winter hemisphere is possibly the result of the asymmetry of the earth's magnetic field with respect to the earth-sun line. (auth)

16421 ASYMPTOTIC CONES OF ACCEPTANCE OF COSMIC RAY NEUTRON MONITORS IN A GEOMAGNETIC

FIELD DISTORTED BY THE SOLAR WIND. H. Razdan and Audrey L. Summers (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 70: 719-24(Feb. 1, 1965).

The asymptotic cone of acceptance is the solid angle containing the asymptotic directions of approach of cosmic-ray particles outside the influence of the geomagnetic field that significantly contribute to the counting of a ground detector. Cosmic-ray trajectories were calculated numerically on an IBM 7090 computer, and the asymptotic cones for a distorted geometric field were compared with those for a dipole field. The trajectory behavior near the geomagnetic cutoff for a dipole and the distorted geomagnetic field were also compared. Tables of results are given. (M.J.T.)

16422 UPPER LIMITS ON GALACTIC COSMIC RAY ANTIPROTON INTENSITIES. S. N. Milford (Adelphi Univ., Garden City, N. Y. and Grumman Aircraft Engineering Corp., Bethpage, N. Y.) and Stephen Rosen. Nature, 205: 582-4(Feb. 6, 1965).

Upper limits on the production of antiprotons in p-p interactions of primary cosmic radiation with interstellar gas were estimated on the basis of recent cross section data. Upper limits on the antiproton intensities in interstellar space, in the Crab nebula, and for intergalactic space were also obtained. The results indicate that the low-energy antiproton fraction of the primary cosmic radiation is probably much less than 0.3%. (D.C.W.)

16423 ELECTRONIC INSTRUMENTATION FOR AN EXPERIMENT ON COSMIC-RAY EXTENSIVE AIR SHOWERS. U. Gali (Israel Inst. of Tech., Haifa), H. Kasha, D. Ophir, Y. Oren, and K. Sitte. Nuovo Cimento (1), 2: Suppl., 147-59(1964).

A description is given of the detectors, the preparation of detector signals, trigger requirements and coincidence arrangements, signal analysis, and data display and recording for the study of extensive air showers. (C.E.S.)

16424 OBSERVATIONS ON NIGHT-SKY ČERENKOV RADIATION IN EXTENSIVE AIR SHOWERS. I. EXPERIMENTAL ARRANGEMENT AND RESULTS. H. Kasha (Israel Inst. of Tech., Haifa), C. Leibovitz, Y. Oren, B. Reuter, and K. Sitte. Nuovo Cimento (1), 2: Suppl., 160-77(1964).

Cherenkov pulses were recorded at various distances from the core of showers of known size and location to examine the angular distributions of the Cherenkov light. The equipment, reduction of data, array response, accuracy of the method, the size spectrum, the relation between pulse height and shower size, pulse-height fluctuations and distributions, and the lateral distributions were discussed. (C.E.S.)

16425 OBSERVATIONS ON NIGHT-SKY ČERENKOV RADIATION IN EXTENSIVE AIR SHOWERS. II. ANALYSIS AND INTERPRETATION. H. Kasha (Israel Inst. of Tech., Haifa), Y. Oren, and K. Sitte. Nuovo Cimento (1), 2: Suppl., 178-95(1964).

The data on size spectrum, pulse height distribution, and relation between shower size and pulse height are discussed. An attempt is made to sum up the experiences gained both with regard to a more appropriate formulation of a theory of the Cherenkov light associated with EAS and with regard to the technique of Cherenkov detectors in the study of these events. (C.E.S.)

16426 MEASUREMENTS ON THE COSMIC RADIATION INTENSITY IN THE MONT BLANC TUNNEL. C. Castagnoli, A. De Marco, A. Longhetto, and P. Penengo (Universita, Turin). Nuovo Cimento (10), 35: 969-76(Feb. 16, 1965).

Measurements on the muonic vertical intensity at different depths under rock (140; 290; 1325; 4100 ± 100 m w.e.) were performed in the Mont Blanc tunnel. The experimental equipment is described. The results are compared with the results obtained elsewhere. Taking into account the values Z^2/A of the various types of rock, there is a good agreement among all these measurements. The comparison of experimental points with the muonic spectrum at sea level suggests that the Weizsäcker-Williams instead of Kessler-Kessler virtual photon spectrum should be used in the calculation of the energy losses due to nuclear interactions. (auth)

16427 MEASUREMENT OF HYDROGEN NUCLEI IN PRIMARY COSMIC RAYS. H. Hasegawa, S. Nakagawa, and E. Tamai (Rikkyo Univ., Tokyo). Nuovo Cimento (10), 36: 18-34(Mar. 1, 1965).

The isotopic composition and the energy spectrum of singly charged particles of low energy were analyzed using the emulsion stack which was launched on September 4, 1959 from Sioux Falls, S. D. (geomagnetic latitude ~53.5°N) and floated for 8.8 hours under 2.0 g cm^{-2} of residual atmosphere and materials. The grain density vs range method and the multiple scattering method were used for identification of particles. Fluxes of primary protons and deuterons at the top of the atmosphere are (0.22 ± 0.02) protons m^{-2} s^{-1} Mev^{-1} for the kinetic energy range of 82 to 305 Mev for protons, and (0.020 ± 0.008) deuterons m^{-2} s^{-1} sr^{-1} $(Mev/nucleon)^{-1}$ for 56 to 200 Mev/nucleon for deuterons, respectively. The differential energy spectrum of primary protons is given by $E^{-(1.2\pm0.2)}$. On the basis of the experimental results the possibility of the following origins is discussed: galactic cosmic rays, reentrant albedo particles, solar particles, and particles from the inner Van Allen radiation belt. It seems to be probable that the particles observed are partly due to those leaked from the inner radiation belt by the distortion of the earth's magnetic field, although low energy galactic cosmic rays and solar particles may be a part of them. (auth)

16428 INTERPLANETARY ORIGIN OF ENERGETIC PARTICLES. E. N. Parker (Univ. of Chicago). Phys. Rev. Letters, 14: 55-7(Jan. 18, 1965).

It is shown that fast charged particles should be produced in violent motions of the interplanetary plasma. It is suggested that intense fluxes of fast particles of interplanetary origin were observed in the unusual increase of protons below 15 Mev on Sept. 30, 1961, in coincidence with the passage of the blast wave originating at the sun on Sept. 28. (D.C.W.)

16429 THE PASSAGE OF ENERGETIC CHARGED PARTICLES THROUGH INTERPLANETARY SPACE. E. N. Parker (Univ. of Chicago). Planetary Space Sci., 13: 9-49 (Jan. 1965).

The passage of cosmic-ray and energetic solar particles through interplanetary space is illustrated by idealized examples. It is assumed that particles in interplanetary space random walk in the irregularities in the large-scale interplanetary magnetic field. The irregularities move with approximately the solar-wind velocity. The classical probability distribution is described by a Fokker-Planck equation. A general expression for the particle diffusion coefficient K_{ij} is worked out, including scattering in magnetic irregularities and systematic pressure drifts. Magnetometer data of Explorer XVIII shows the close adherence of the quiet-day interplanetary magnetic field to the theoretical spiral angle. Isotropic diffusion in a spherical region $r < R$ with uniform radial wind velocity is considered, to illustrate the nature and duration of the passage of a cosmic particle through the solar system. The energy distribution is given for particles starting with the same energy from interstellar space. The incoming probability wave of a single particle is computed as a function of time. The problem of energetic solar particles is illustrated. The steady-state cosmic-ray intensity is calculated throughout the spherical region $r < R$, assuming uniform interstellar-space cosmic-ray density and isotropic k_{ij}. Indirect observational information on k_{ij} beyond the earth's orbit is discussed. (M.J.T.)

16430 THE MODULATION OF GALACTIC COSMIC RAYS IN THE INTERPLANETARY MEDIUM. W. I. Axford (Cornell Univ., Ithaca, N. Y.). Planetary Space Sci., 13: 115-30(Feb. 1965).

The anisotropic diffusion of cosmic rays in the inter-

planetary medium is discussed with the assumption that the fluctuating component of the magnetic field produces a scattering effect which can be described by a simple mean free path treatment. The results of this discussion are applied to a plausible model of the interplanetary medium with the aim of providing a basis for the understanding of the processes causing the more important modulations of the galactic cosmic ray intensity. It is suggested that a gradient of the cosmic-ray density exists and plays a significant role in producing the solar cycle and 27-day modulation effects. In addition, the associated cosmic ray pressure gradient might affect the size of the cavity resulting from the interaction between the solar wind and the interstellar medium. Since the gradient could be present even at sunspot minimum, it is possible that the energy density of cosmic rays in the galaxy is larger than the maximum value observed at the Earth, and hence this value should be regarded only as a lower limit. The main contribution to the solar diurnal variation of the cosmic ray intensity is suggested to be due to co-rotation of the cosmic rays with the Sun. However, above a certain energy, which varies through the solar cycle, the galactic cosmic rays appear to be unaffected by the roughness of the interplanetary magnetic field, thus any streaming which occurs at these higher energies should cause a sidereal diurnal variation of the intensity. (auth)

16431 ANALYSIS OF COSMIC RAY JETS ON THE BASIS OF THE LINKED HEAVY PARTICLE MODEL. Tetsuro Kobayashi (Waseda Univ., Tokyo), Mikio Namiki, Ichiro Ohba, and Shuji Orito. Progr. Theoret. Phys. (Kyoto), 32: 738-49(Nov. 1964).

Recent experiments of cosmic ray jets are analyzed on the basis of the linked heavy particle model. The model should be regarded as an attempt along the line of thought that the inner heavy boson and/or $N\bar{N}$ pair clouds of colliding nucleons are mainly responsible for the multiple particle productions in NN collisions at very high energies. From the ICEF data, the total energy of charged secondaries E_{ch}, the multiplicity of charged secondaries n_s and the invariant four momentum transfer squared Δ^2 are obtained, which yield the n_s vs. E_{ch} plot, the Δ vs. E_{ch} plot and the n_s vs. Δ^{-1} plot. It is clarified that the wide fluctuation of the n_s vs. E_{ch} plot can be successfully parametrized by Δ, and that the fluctuation can be reproduced from the formula of the model substituted by the values of the Δ vs. E_{ch} plot. This means that the experiments are consistent with the linked heavy particle model. It is easily seen from the Δ vs. E_{ch} plot that the mean value of Δ is of the order of magnitude of the nucleon mass irrespective of E_{ch}, and that the fluctuation of Δ around its mean value becomes large with increasing E_{ch}. Finally the mean variances of the multiplicity δn_s are plotted against the average multiplicity $\langle n_s \rangle$. This plot may inform one about the final states of produced bosons. (auth)

16432 ENERGY DEPENDENCE OF THE Δ_{11}-DISTRIBUTIONS IN MULTIPLE PARTICLE PRODUCTION. Mikio Namiki and Ichiro Ohba (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 866-8(Nov. 1964).

The experimental values of four momentum transfer Δ_{11} distributions determined from cosmic ray data are discussed, and an attempt is made to show that the experimental results are consistent with theory. The energy dependence of the Δ_{11} distribution is illustrated. (C.E.S.)

16433 EXTRA-GALACTIC COSMIC RAYS. Yoichi Fujimoto, Hiroichi Hasegawa, and Mituo Taketani (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 975-7 (Dec. 1964).

The energy spectra of galactic and extra-galactic cosmic rays were estimated, assuming a cutoff at about 10^{16} ev for the galactic cosmic-ray spectrum. The theoretical spectra were compared with the observed energy spectrum of primary cosmic rays. The results support the view that cosmic rays with energy over about 10^{17} ev are of extra-galactic origin. (D.C.W.)

16434 HIGH-ENERGY SOLAR PARTICLE EVENTS. J. G. Roederer (Universidad, Buenos Aires). p.115-45 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

The problem of how to associate the unknown solar particle flux, energy spectrum, and angular distribution in space to measurements made on the earth's surface is considered, with a discussion of geomagnetic deflection and nucleon cascades. Experimental evidence about the propagation, scattering, and trapping of high-energy particles in space is reviewed. Hydromagnetic mechanisms for the injection, confinement, acceleration, and release of solar particles by solar flares are discussed. 66 references. (M.J.T.)

16435 COSMIC RADIATION AND SOLAR MODULATION. Peter Meyer (Univ. of Chicago). p.147-60 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

A review is given of research aimed at the description of the mechanisms by which the sun influences the flux of galactic cosmic-ray particles into the inner solar system. The anticorrelation between solar activity and cosmic-ray intensity and its rigidity dependence are discussed. Tests of the solar-wind model for changes in intensity and energy-spectrum of cosmic radiation by space probes are summarized. (M.J.T.)

16436 VERY HIGH ENERGY COSMIC GAMMA RAYS. M. Lieber, S. N. Milford, and M. S. Spergel (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). 19p. (CONF-640606-11)

From American Physical Society Summer Meeting, Denver.

Collisions of high-energy cosmic rays with intergalactic gas produce various secondaries, including neutral pions that decay into high-energy γ rays. The Landau-Milekhin hydrodynamical model for proton-proton collisions is used to calculate the pion production spectrum corresponding to cosmic γ rays of energy above 10 Bev. A source function for these high energy γ rays in space is found by combining the pion production and decay spectra with the primary cosmic proton flux. The resulting γ spectrum follows a different power law than spectra based upon the usual assumption of a line spectrum for the pions in the center of mass system of the colliding protons. The high-energy γ intensity in space is calculated for a simple model universe. By comparison with previous estimates for the proton photoproduction process, it is found that proton-proton and proton-photon collisions appear to contribute about the same order of magnitude to the intergalactic γ intensity above $\sim 10^{15}$ ev. (auth)

Criticality Studies

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstract 17244.

16437 (HW-83603) PROGRESS IN PLUTONIUM CRITICAL MASS PHYSICS. A Summary of Hanford Laboratories Achievements in These Programs Under General Electric, 1961–1964. E. D. Clayton (Hanford Atomic Products Operation, Richland, Wash.). Oct. 1964. Contract AT(45-1)-1350. 42p. Dep.; $2.00(cy), 1(mn) CFSTI.

Technical accomplishments and relevant activities performed in the Hanford Plutonium Critical Mass Laboratory since 1961 are reviewed. Several hundred critical-mass determinations have been made with plutonium in a Critical Mass Laboratory. This facility was specially designed and equipped to handle plutonium. Nearly three-fourths of the experiments were performed with plutonium nitrate solutions; the others were performed with PuO_2-plastic mixtures (solids) using a remote split-table machine. There have been no unusual incidents involving any of the critical assemblies during the conduct of these experiments. (auth)

16438 (ORNL-3714(Vol.I)(p.31-42)) CRITICAL EXPERIMENTS. (Oak Ridge National Lab., Tenn.).

Research summaries are presented on critical experiments using enriched U cylinders, critical dimensions of enriched aqueous UO_2F_2, geometrically complicated enriched-U critical assemblies, critical experiments with enriched U, prompt-neutron lifetime in critical U cylinders HFIR critical experiments, reactivity effects of perturbations in critical experiments, and neutron multiplication in fissile material. References to publications in which the research is described are included. (J.R.D.)

Direct Energy Conversion

Refer also to abstracts 16195, 16196, 16197, and 16366.

16439 (AD-604997) RESEARCH AND DEVELOPMENT OF MATERIALS AND FABRICATION TECHNIQUES FOR THERMOELECTRIC POWER GENERATION. Final Report, January 1, 1962–April 1, 1963. (General Electric Co., Lynn, Mass. Direct Energy Conversion Operation). Dec. 10, 1963. Contract NObs 86854. 64p. $2.00(CFSTI).

The development effort is described. Hardware in the area of the cartridge couple, and progress in the development of advanced thermoelectric materials is described. (auth)

16440 (AD-609177) INVESTIGATIONS ON THE DIRECT CONVERSION OF NUCLEAR FISSION ENERGY TO ELECTRICAL ENERGY IN A PLASMA DIODE. Report No. 5. Annual Report, November 1, 1963–October 31, 1964. C. B. Leffert, D. B. Rees, and F. E. Jamerson (General Motors Corp., Warren, Mich. Research Labs.). Contract Nonr-3109(00). 113p. $4.00(CFSTI).

Six sections are included; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual sections see: 16249, 16250, 16366, 16441, 16442, and 17253.

16441 (AD-609177(Sect.C)) COMPUTER SOLUTIONS TO THE REACTOR KINETICS EQUATIONS. (General Motors Corp., Warren, Mich. Research Labs. 11p.

The seven simultaneous equations which describe the reaction kinetics in a plasma generated by fission fragment ionization of a Penning-type gas mixture were solved on the IBM digital computer. The results of the first parametric studies on the effects of pressure, concentration of the minority gas species, and the electrode spacing are discussed. The first runs confirmed the approximate solutions obtained analytically. Using the full set of equations in the code it was found that in the recombination of the molecular neon ions if an appreciable fraction (~.5) produces the metastable states of neon, these in turn increase the production rate of argon ions and significantly increase the electron number density (~ × 2). Reducing the electrode spacing from .33 to .051 cm increased the diffusion losses and greatly decreased the electron number density. This result showed that further theoretical work must be done before this tool can be used to optimize the performance of a thermionic energy converter. (auth)

16442 (AD-609177(Sect.E)) ION GENERATION RATE MEASUREMENTS IN AN ARGON–CESIUM MIXTURE. (General Motors Corp., Warren, Mich. Research Labs.). 18p.

Ion generation rate measurements were made on an argon-cesium gas mixture using modified versions of the noble gas ionization tube. Data from the first two tubes were inconclusive, owing to the difficulty of transporting cesium vapor in argon (at 240 torr) for the tube configuration used. A study of cesium transport in argon showed that a period of one to two hours is needed to establish equilibrium and this suggested further modifications to tube design. The third ion tube, thus modified, operated successfully in the reactor. The data indicated that for Cs/Ar ratio of 10^{-5} at an argon pressure of 240 torr, the I-V data followed a $(V)^{\frac{1}{2}}$ relationship, and that the ion generation rate is significantly higher than that for Ne–Ar or the pure gases for the same condition. (auth)

16443 (AERE-M-1398) COMPUTER PROGRAMMES FOR USE IN ENERGY CONVERSION. R. S. Ash. Atomic Energy Research Establishment, Harwell (England)). May 1964. 33p. Dep.(mn).

The Mercury Autocode programs are listed that have been written to aid calculations on various aspects of energy conversion. The purpose of each is described and the expressions that have been programmed are stated. Also shown are available tabulated values, and the range of the corresponding independent variables. Each program can be modified to print out the values for additional steps in the calculation, and to include other ranges of the independent variables. (auth)

16444 (AFAPL-TR-64-135) HIGH-TEMPERATURE THERMOELECTRIC RESEARCH. C. M. Henderson, R. G. Ault, E. R. Beaver, D. H. Harris, W. H. Hedley, and R. J. Janowiecki (Monsanto Research Corp., Dayton, Ohio). Oct. 30, 1964. Contract AF33(615)-1084. 322p. (AD-609051). $7.00(CFSTI).

Nominal 50 and 15-watt(e) laboratory model generators were designed, fabricated and subjected to sustained and thermal cycling tests at a hot-junction temperature of ~1200°C and cold-junction temperature of ~570°C, in a vacuum of 10^{-5} to 10^{-6} torr. Both generators, constructed of solid-state, bonded, segmented, p- and n-type thermoelements, showed resistance to degradation under these conditions. The 50-watt generator completed ~1200 hours of operation without degradation of its power output. The output of the 15-watt model, after 2100 hours without degradation, decreased by 9% during an additional 1400 hours of sustained testing and a further 264 hours of thermal cycling tests. Degradation of the 15-watt model appears to result largely from deterioration of the electrical resistance of the ceramic insulation used to reduce its thermal shunt losses. Improvements in the properties of thermoelectric materials and interface bonding techniques for thermoelements were achieved. Various techniques were investigated for screening p- and n-type thermoelements to 1200°C in a vacuum. Fundamental investigations were made of the thermoelectric materials and studies of hot-pressing and arc-plasma fabrication techniques. Nuclear reactor, radioisotope, and solar-heated high-temperature thermoelectric space-power system concepts were proposed and preliminarily investigated. These studies showed that high-temperature (1200°C) thermoelectric space-type power units, ranging in size from a few watts to several hundred kw output, can be designed for performances from 335 lbs./kw(e) for a solar-concentrating type system to 15 lbs./kw(e) for 350-kw(e) or larger space-power systems utilizing fast-reactor heat sources. High-temperature, radioisotope-heated, thermoelectric space-type units, of optimized design concepts and fabricated with state-of-the-art segmented p- and n-type thermoelements, are capable of 7 to 9.5 watt (e)/lb. (100 to 140 lb./kw(e)) performance, including the weight of the encapsulated isotope heat source. (auth)

16445 (ANL-6900(p.304-29)) ENERGY CONVERSION. C. E. Crouthamel (Argonne National Lab., Ill.).

Work on the development of methods for the conversion of heat into electrical energy was continued. Two types of regenerative cells are being studied, bimetallic concentration cells and the hydride cell. Regeneration studies of the Na–Bi bimetallic system were made with the Knudsen effusion-mass spectrometer technique. No intermetallic species were found in the gas phase. The mass peak due to Bi appeared after the Na content dropped from the original 0.75 (in Na_3Bi) to 0.6 mole fraction and at about 690°K. The total pressure of Bi ($p_{Bi} + p_{Bi_2}$) and the Na pressure are calculated as a function of temperature and composition of the condensed phase. The data indicate that separation of Na from the Bi is possible. Experimental Na-Bi cells were assembled in opentop crucibles and were operated at 575 to 685°C with NaCl-NaI electrolyte and from 300 to 500°C

with NaOH-NaI electrolyte and at currents as great as 145 ma/cm² at 0.28 volt. Open-circuit voltages as a function of mole fraction of Na in the Bi cathode at 576°C were obtained. The effect of the solubility of Li_3Bi intermetallic in the electrolyte on the previously reported emf-temperature-composition surface of the Li-Bi system was investigated in detail. No error in the previous data resulted from this phenomenon. The emf of the cell: Li(l) satd. with Li_3Bi(s)/LiCl-LiF/Bi(l) satd. with Li_3Bi(s) was identical, within 2.0 mv, with the emf of a cell containing a pure Li liquid anode. The solubility of Li_3Bi in the fused LiCl-LiF eutectic for temperatures between 600 and 1000°C ranges from 0.05 to 1.5 mole %. A ΔH_f for Li_3Bi estimated from the solubility data is 9.4 kcal/mole. Below 800°C, the solutions of Li_3Bi in Li salts are a clear deep red. At 800°C, the solutions are virtually opaque to visible light. At 525°C, the absorption spectrum is characterized by an intense absorption band whose long wavelength edge is at 610 mμ. This edge shifts 40 mμ to lower energies for each 100°C rise in temperature. Alloys of Li-Bi containing 50 at.% of each metal were equilibrated with a eutectic mixture of LiCl-LiF. The atom ratio of Li-to-Bi is not 3.0 (as it is when a 70 at.% Li–30 at.% Bi alloy is equilibrated with the same eutectic), but approaches 1.0, probably as a result of the dissolution of more than one species in the eutectic, e.g., Li_3Bi and LiBi. The absorption spectrum of Li_2Te in LiCl-LiF eutectic mixture was measured. The solutions are clear red and are relatively stable in silica absorption cells. The spectrum is characterized by a peak at 469 mμ and an intense charge transfer band whose long wavelength edge is at 377 mμ. A molar absorptivity of about 25.0 was obtained for the Li_2Te species. The spectrum of Cs_2Te has been observed in CsCl. The solutions are blue with a strong peak at 635 mμ, a weaker peak at 465 mμ, and a charge transfer band whose long wavelength edge is at 340 mμ. Saturated solutions in Li and Cs halides are estimated to range in the 1 to 10 M concentration range at 400 to 700°C. The LiH cell as well as bimetallic cell combinations of various anode and cathode metals are being considered from an engineering viewpoint, both as concerns cell operation and electrode material regeneration. Studies of the solid-liquid equilibria of LiH binary systems with LiCl, LiBr, and NaCl were completed as a part of the evaluation of electrolytes for the LiH cell. Detailed data for the LiH-NaCl system are reported. All three systems are discussed and the evidence for associated Li_2Cl_2, Li_2Br_2 and NaCl species in LiH solvent is presented. LiH cell studies with a flag H_2, H^- electrode and solid LiH in the cell electrolyte gave stable, reproducible emf data suitable for thermodynamic calculations pertinent to the regenerative cell program. The cell represented as follows Li(l), Li^+/LiCl-LiH satd. with LiH(s)/H^-, H_2(g) gives 0.2908 ± 0.0002 volt at 813.0 ± 0.5°K and with one atmosphere of H_2. The cells were reproducible with cycling at 510 to 610°C. The $(\partial E^0/\partial T)_p$ was obtained as -7.29×10^{-4} volts/deg. The slope is constant at 510 to 610°C. The standard free energy of formation of LiH calculated from these data using the best available heat capacity and enthalpy data for Li metal, LiH and H_2 gas is $\Delta F^0_{f,298} = -15{,}850$ cal/mole. This is consistent with calorimetric data in the literature. From these data $\Delta H^0_{f,298} = -21{,}180$ cal/mole and $\Delta S^0_{f,298} = -17.9$ eu. Permeation of H_2 through pure V metal diaphragms was found to be variable, but even the lowest rates observed would support over 100 ma/cm² current densities. The variability observed is believed to be due to intrinsic characteristics of V metal as an exothermic occluding metal rather than surface contamination. V metal diaphragms were operated in cells and give open circuit voltages similar to Fe metal diaphragms. A cell was operated 540 hours using a V diaphragm. The cell, operated intermittently under resistive load throughout the run, produced 130 ma/cm² at one-half the open circuit voltage. The diaphragm showed no signs of corrosion. (J.R.D.)

16446 (MHD-666) EXPLOSIVE MAGNETOHYDRODYNAMICS. Quarterly Technical Progress Report No. 3, October 1–December 31, 1964. Malcolm S. Jones, Jr., Francis H. Webb, Jr., Paul Webster, Sydney Handlin, Richard Harrison, and Guenter Guthoff (MHD Research, Inc., Newport Beach, Calif.). Jan. 15, 1965. Contract AF33(615)-1594. 37p.

Experimental studies on the production of short duration pulses of electric power by MHD principles in a radial flow channel are presented. Plasma currents in excess of 10^4 amperes were measured in a radially expanding explosive driven plasma. The plasma conductivity was less than had been expected on the basis of experiments conducted in linear channels. Designs for generators capable of producing electric power outputs up to 4×10^{12} watts for 10 microseconds are discussed. (auth)

16447 (NASA-TN-D-2651) BRAYTON CYCLE MAGNETOHYDRODYNAMIC POWER GENERATION WITH NONEQUILIBRIUM CONDUCTIVITY. John E. Heighway and Lester D. Nichols (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Feb. 1965. 49p. $2.00(CFSTI).

Power densities of magnetohydrodynamic generators operating in a Brayton cycle with nonequilibrium conductivity are computed. Helium, neon, argon, and xenon with cesium seed are considered as working fluids in a constant-area, constant-voltage, segmented generator operating in the Faraday mode. The generator performance is specified by optimizing the cycle efficiency with respect to load voltage and by optimizing output power density with respect to seed fraction and operating pressure. The power density is determined as a function of Mach number and magnetic field strength. Argon exhibits the highest power density in the supersonic regime and neon the highest in the subsonic regime for the particular generator and cycle considered. (auth)

16448 (TID-21380(p.85-111)) PLASMA MAGNETOHYDRODYNAMICS AND ENERGY CONVERSION. G. A. Brown, E. N. Carabateas, R. S. Cooper, et al. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

The features and limitations of a MHD conduction generator with diverging channel for liquid metal flow are discussed. In such a generator part of the dynamic head at the inlet can be converted to static pressure offsetting the body forces induced by magnetic fields and increased frictional pressure drop caused by the flattening of the velocity profile by the magnetic field. Research is reported on losses in superconducting Nb–Zr solenoids at low frequencies. Work on a model magnetohydrodynamic induction machine of finite length is also reported. An analysis of the thermal effects in determining the penetration for an ion in a partially mobile film is included. Research on electron and ion emission from W monocrystals is also reported. (J.R.D.)

16449 (TRW-ER-5632) HIGH-TEMPERATURE SOLAR THERMIONIC GENERATORS. Quarterly Technical Progress Report, August 1, 1963–October 31, 1963. (TRW Electromechanical Div., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). Nov. 15, 1963. Contract AF33(657)-11169. 31p. (AD-423713). $3.60(CFSTI).

The fabrication of four Series 300 thermionic converters and the initiation of sustained performance evaluations of three of the four are reported. One of the converters (#302) is being operated continuously while the other two (#303 and #305) are being cycled to simulate the 55 minute ON, 35 minute OFF orbital cycle operation. Design emitter temperature is 2000°K and nominal output power to the load at 0.7 volts is 21 watts (7 watts/cm sq). To date, a total of 545 hours of continuous operation was recorded for converter #302 with no decrease in performance. Converter #303 withstood a total of 430 cycles when an apparent internal emitter-to-collector short occurred. A failure analysis is currently being performed on this converter. Converter #305 has accumulated a total of 540 cycles. Performance data taken during cycle 509 showed a 17.5% decrease in power output. During the last 32 cycles the performance has held essentially constant at the reduced power output. Test of this converter is continuing. A Demonstrator Model Test Stand and Auxiliary Support Vacuum System were fabricated and tested. This

equipment was used during the acceptance test of converter #304 and met or exceeded all performance specifications. (auth)

16450 INFLUENCE OF MAGNETIC FIELD ON CESIUM THERMIONIC ENERGY CONVERTER. J. Kramar (Research Inst. of Electrical Engineering, Bechovice, Czechoslovakia). Czech. J. Phys., 15: 190-200(1965).

The influence of the magnetic field upon the electric current of a thermionic converter is studied, presupposing the approach to conditions in a low-pressure cesium converter. The distribution of the starting velocities of the emitted electrons is considered first as independent of the angle from the perpendicular to the emitter plane, and then according to the cosine law. The magnetic field effect from the converter current is calculated and compared with the calculations by Schock and Block; the effect of the external magnetic field is verified by measurements on a solar thermionic converter prototype. (auth)

16451 THE PRESENT STATE OF THE DEVELOPMENT OF NUCLEAR THERMIONIC REACTORS. Vincent Polak. Jaderna Energie, 11: 12-20(Jan. 1965). (In Czech)

Problems connected with the development of nuclear thermionic reactors are discussed. Evaluations of different types of nuclear thermionic converters from the point of view of their use in the design of nuclear thermionic reactors, descriptions of the approach to these reactors at the present time, the advantages, disadvantages, and possible mode of using these reactors, a review of requirements of their development, and a comparison between thermionic thermal cycles and classic thermal cycles are given. A cesium thermionic diode is considered to be a convenient fundamental element for the design of nuclear thermionic reactors. (auth)

16452 THERMIONIC CONVERSION, A POSSIBILITY OF THE DIRECT TRANSFORMATION OF HEAT ENERGY TO ELECTRIC ENERGY. Klaus Leibrecht. Z. Angew. Phys., 18: 53-60(Nov. 5, 1964). (In German)

Considerations are made on the development of transformation processes with substantially higher efficiencies than the classical processes, the supplement of classical thermal power machines through direct transformation to obtain higher temperatures, and the use of sunlight energy. The mode of operation based on the laws of thermodynamics and statistical mechanics is discussed. Factors relating to thermal energy loss are pointed out: thermal radiation of the cathode, heat power of lead wires to the cathode, electrode attachments, and the potential drop in the electrical leads. Theoretical and measured efficiencies are discussed; and curves for current-potential characteristics, the output power as a function of current, and current as a function of cathode temperature for thermionic converters are shown. Methods for reducing the effect of space charge are presented. (L.B.S.)

16453 CONDUCTION PHENOMENA IN CAESIUM PLASMA. Árpád Ág (Research Inst. for Telecommunication Techniques, Budapest). p.191-200 of "Proceedings of the Symposium on Electron and Vacuum Physics, Hungary, 1962." Budapest, Publishing House of the Hungarian Academy of Sciences, 1963.

The variations of the open-circuit voltage of a Cs diode as a function of Cs vapor pressure and cathode temperature were investigated by the aid of equations relating to diffusion and recombination. It was thus possible to interpret the potential hill and its appearance and disappearance at given pressures and cathode temperatures. The theoretical curve is in close agreement with the empirical one on assuming reasonable values for the assumed constant (d). (auth)

16454 REPORT ON THE TWENTY-THIRD ANNUAL CONFERENCE ON PHYSICAL ELECTRONICS HELD MARCH 20, 21, AND 22, 1963 AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. Cambridge, Mass., Massachusetts Institute of Technology, 1963. 428p. $6.00. (CONF-538)

Separate abstracts were prepared for eleven of the 47 papers included. Four other papers were previously abstracted for NSA (18: 12429, 20788, 28313, and 19: 9970). The remaining papers deal with materials studies, instrumentation, thermionic cell characteristics, and plasma studies. (D.C.W.)

For abstracts of individual papers see: 15845, 15846, 16181, 16182, 16455, 16456, 16457, 16458, 17138, 17139, and 17140.

16455 EFFECT OF EMITTER WORK FUNCTION PATCHES ON THE PERFORMANCE OF CESIUM THERMIONIC CONVERTERS. E. N. Carabateas and J. W. Gadzuk (Massachusetts Inst. of Tech., Cambridge). p.250-8 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

It is shown that the continuous increase in output current with decreasing output voltage in a Cs thermionic converter (the fact that the emission current does not show a sharp saturation value) may be due to patches of different work function on the emitter surface. It is shown that an exponential Boltzmann type distribution of these patches may account for the shape of the current-voltage characteristics obtained from a cesium thermionic converter with a monocrystal Mo emitter in the region of low output voltage. From the analysis of these characteristics the percentage area with the exponential distribution is determined. Furthermore, the exponential type distribution characterized by the emitter temperature indicates that these patches may be caused by thermal excitation. (auth)

16456 MEASUREMENT OF EMITTER HEAT BALANCE IN A CESIUM THERMIONIC CONVERTER. J. M. Houston (General Electric Research Lab., Schenectady, N. Y.). p.376-92 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

Measurements were made on a cylindrical, indirectly heated Cs-vapor thermionic converter having a stainless-steel collector spaced 1 mm from a 13.3 cm^2 Th–W emitter. At an emitter temperature of 2200°K, a power output of 8.8 $watt/cm^2$ (at 1.2 v) at a measured overall efficiency of 11.9% was observed. Measurements of the cooling of the emitter due to electron emission indicate that in the retarding range of the converter the emission cooling is just what simple theory would predict, the electron temperature in the plasma being equal to the emitter temperature. However, for collector-to-emitter voltages more positive than approximately −1.3 v, the emission cooling fell far below that predicted by simple electron emission from the emitter, indicating that large amounts of power (as much as 20 w/cm^2 at positive collector voltages) was flowing from the plasma back to the emitter. This anomaly in emission cooling is due to Cs excited atoms, ions, and resonance radiation returning to the emitter. These originate in a region of high electron temperature adjacent to the emitter. (auth)

16457 TRANSPORT EFFECTS IN THERMIONIC CONVERTERS. George N. Hatsopoulos (Thermo Electron Engineering Corp., Waltham, Mass.). p.393-9 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

Electron transport effects were investigated using a cesium thermionic diode with a tungsten emitter. Space charge neutralization by both surface and volume ionization was considered. The experimental results were compared with theoretical predictions. (D.C.W.)

16458 TRANSPORT EFFECTS IN THE UNIGNITED MODE OF THERMIONIC DIODES. C. Warner and L. K. Hansen (Atomics International, Canoga Park, Calif.). p.400-12 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

Two important transport losses in practical therm-

ionic converters are resistive losses which reduce voltage output, and backscattering of electrons which reduces the current output. The first losses are associated with the mobility of the charged particles in electric fields, while the second losses are associated with the diffusion rates in concentration gradients. Converter characteristics for the unignited (surface ionization) mode are compared with theoretical results obtained from a plasma model containing both mobility and diffusion losses. The degree of agreement found demonstrates that the two losses are equally important to understanding converter characteristics. (auth)

16459 APPLICABILITY OF THERMOACOUSTIC PHENOMENA TO MHD CONVERSION SYSTEMS. R. L. Carter, K. T. Feldman, Jr., and C. N. McKinnon, Jr. (Univ. of Missouri, Columbia). 8p. (CONF-640403-1)

From 5th Symposium on the Engineering Aspects of Magnetohydrodynamics, Cambridge, Mass.

Systems are discussed in which thermal energy is used directly to produce oscillation of an ionized gas in a duct passing transversely through an external magnetic field, thereby producing an alternating electric current. (D.C.W.)

16460 MATERIALS, STRUCTURES, AND JET TESTING OF MATERIALS FOR OPEN CYCLE MAGNETOHYDRODYNAMIC CONVERSION. D. Yérouchalmi (Commissariat a l'Energie Atomique, Saclay, France). 14p. (CONF-640701-13). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Research on the testing of materials and structures containing open-cycle MHD conversion jets heated by combustion gases was undertaken by the CEA and the Institut Francais du Pétrole. A program of test selection was established. This program and its development, in progress at the present time, are described in broad outlines. (J.S.R.)

16461 SUPERCONDUCTING WINDING OF IRON FOR MHD GENERATOR. M. L. Donadieu (Compagnie Generale d'Electricité, Marcoussis, France). 8p. (CONF-640701-15). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The magnetic circuit and comparative dimensions of conventional and superconducting windings were calculated. The effect of the magnetic circuit with iron on the functioning of superconducting windings was studied experimentally. The test were made systematically with and without core, as its introduction significantly modifies the lines of force and the energy of the magnetic field. The degradation effects of the induction/current characteristics of Nb–Zr (25%) between a short sample and a long cable were studied. (J.S.R.)

16462 COMPARATIVE STUDY OF DIFFERENT PROCEDURES FOR OBTENTION OF A MAGNETIC FIELD FOR AN INDUSTRIAL MHD GENERATOR. G. Delile (Electricité de France, Paris). 9p. (CONF-640701-16). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The economic conditions for the utilization of classical water-cooled, cryogenic, and superconducting coils were studied, and the solutions to which they lead were compared. The construction price was established from data from suppliers, and the calculation hypotheses were those generally adopted in technico-economic studies of classical power plants. (J.S.R.)

16463 THE THEORY OF LARGE AMPLITUDE OSCILLATIONS IN THE ONE-DIMENSIONAL LOW PRESSURE THERMIONIC CONVERTER. Peter Burger (Stanford Univ., Calif.). 23p. (CONF-641108-7)

From American Physical Society, New York.

The large amplitude oscillations in a one-dimensional low-pressure thermionic converter are analyzed. With the help of results obtained from computer calculations designed to stimulate the operation of the converter, the current oscillations are explained in terms of the changing forms of the potential distribution in the system. The variations in the form of the potential function are explained by means of the concept of a "temporary d-c state." Such a state differs from the ideal self-consistent state in that the electrons and the potential adopt new distributions, while the ion distribution stays the same as in the self consistent state. In fact, the ions are treated as too heavy to respond to the new potentials while the electrons adjust rapidly to them. The existence of a temporary d-c state is decided by solving a static problem only; but if such a state exists, then there is a possibility for relaxation type of oscillations in the system with frequencies characteristic to the ions. (auth)

16464 THE FEASIBILITY OF MHD POWER GENERATION. W. S. Emmerich (Westinghouse Electric Corp., Pittsburgh). 6p. (CONF-641014-1)

From 2nd Annual Conference on Energy Conversion and Storage, Stillwater, Okla.

The use of MHD generators to improve the efficiency of large power plants is discussed with consideration of the problems and principles of MHD generators, types of MHD generators, experimental results, the associated power plant, and some research on combustion-driven MHD generators. (D.C.W.)

16465 MAGNETOHYDRODYNAMIC VOLTAGE GENERATOR. Rudolf X. Meyer (to Thompson Ramo Wooldridge Inc.). U. S. Patent 3,155,850. Nov. 3, 1964. Filed Feb. 26, 1960.

A voltage generator in which the heat energy of a plasma is converted directly into electrical energy by passing the plasma through a magnetic field at high speeds is described. The device includes means for generating a magnetic field in an annular passageway through an iron core. At least one pair of electrodes is mounted substantially radially in the passageway. An ionized gas is injected at high speed through a nozzle into the passageway. The interception of the magnetic field by the ionized gas causes an electrical current to flow between the electrodes. (A.G.W.)

Elementary Particles and Radiations

Refer also to abstracts 15867, 15911, 16368, 16707, 16709, and 16723.

16466 (AEET/HP/Th-9) RADIATION DOSE FROM VOLUME SOURCES. T. N. Krishnamurthi, V. K. Sundaram, and P. P. Damle (Atomic Energy Establishment, Trombay (India)). 1962. 36p. Dep.(mn).

Exact integral expressions for gamma flux at different points from finite cylindrical and spherical sources, having uniform source distribution, are presented. The type of geometry chosen for the evaluation of the flux simplifies the integrand to a great extent. The integral expressions are computed for two specific cases of cylinder and sphere using TIFRAC Digital Computer for general values of the parameters involved, and the curves are presented. (auth)

16467 (JINR-E-1898) METHOD OF INVESTIGATING ELASTIC pp-SCATTERING IN THE HIGH-ENERGY REGION WITH SEMICONDUCTOR DETECTORS. Yu. K. Akimov, A. I. Kalinin, M. N. Khachaturyan, V. A. Nikitin, V. S. Pantuyev, A. I. Sidorov, and V. A. Sviridov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1964. 5p.

The energy spectrum of particles emerging at an angle of 87.7° from a thin $(CH_2)_n$ target bombarded with 10-Bev protons has been measured with a semiconductor detector. An obvious peak has been observed, which corresponds to recoil protons in elastic p-p scattering. (auth)

16468 (JINR-P-1918) INTEGRAL'NOE PREDSTAVLENIE DLYA DVUKHCHASTICHNOI AMPLITUDY V NERELYATIVISTSKOM SLUCHAE. (An Integral Representation for the Two-Particle Amplitude in the Nonrelativistic Case). M. A. Mestvirishvili (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1964. 12p. Dep.(mn).

An integral representation for the two-particle amplitude off the energy shell is proposed in the nonrelativistic case. The obtained integral representation gives the analytical properties of the two-particle amplitude. (auth)

16469 (JINR-P-1919) ISSLEDOVANIE ENERGETICHESKIKH SPEKTROV I UGLOVYKH KORRELYATSII CHASTITS V RASPADAKH $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$. (An Investigation of the Energy Spectra and the Angular Correlations of Particles in the $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$ Decay). D. M. Kotlyarevskii, A. N. Mestvirishvili, D. Nyagu, E. O. Okonov, N. I. Petrov, V. A. Rusakov, L. V. Chkhaidze, and Tsung-fan Wu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy; and Akademiya Nauk Gruzinskoi SSR. Institut Fiziki). 1964. 15p. Dep.(mn).

The spectrum and angular correlations of particles in the $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$ decay are investigated using a cloud chamber in a magnetic field. It was established on the basis of 360 K_{e3} decays that in the framework of the universal weak (V-A) theory the vector interaction is in agreement with experimental data. The form-factor g_v depends weakly on the pion energy. Neither the scalar nor tensor can be considered as the only one responsible for interaction. Their possible contributions to the decay interaction do not exceed 10 to 15%. The charge ratio in the K_{e3} decay is also given. (auth)

16470 (JINR-P-1920) EKSPERIMENTAL'NOE OPREDELENIE VEROYATNOSTI RASPADA $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$. (An Experimental Determination of the Decay Probability $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$). G. N. Vardenga, D. M. Kotlyarevskii, A. N. Mestvirishvili, D. B. Nyagy, E. O, Okonov, N. I. Petrov, V. A. Rusakov, and Tsung-fan Wu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy; and Akademiya Nauk Gruzinskoi SSR. Institut Fiziki). 1964. 4p. Dep.(mn).

Data are presented which are concerned with a determination of the relative probability of the $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$ decay (with respect to all the decays having charged products). The obtained value 0.48 ± 0.07 agrees well with the isotopic spin selection rule $|\Delta I| = 1/2$. (auth)

16471 (JINR-P-1927) O ELEKTROMAGNITNYKH SVOISTVAKH ELEMENTARNYKH CHASTITS V MODELYAKH G_2 I B_2 SIMMETRII. (On Electromagnetic Properties of Elementary Particles in G_2- and B_2-Symmetries). Edvard Kapustsik (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep.(mn).

The electromagnetic properties of elementary particles in the models of G_2 and B_2 symmetries are investigated. The results show that the G_2 symmetry cannot be treated as the main model of higher symmetry. (auth)

16472 (JINR-P-1933) O VZAIMODEISTVII MASSIVNOGO NEITRINO SO SVETOM. (On an Interaction of a Massive Neutrino with Light). R. A. Asanov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep.(mn).

Within the framework of four-fermion weak interaction, the cross sections have been obtained for the following processes involving neutrino with non-zero rest mass: elastic scattering of light on a neutrino; neutrino-antineutrino pair production by photon collision; and photon production in the annihilation of neutrino pairs. The electromagnetic radiation by a $\nu-\tilde{\nu}$ "superstar" has been estimated. (auth)

16473 (JINR-P-1939) MAGNITNYE MOMENTY BARIONOV V MODELI KVARKOV. (Magnetic Moments of Baryons in the Quark Model). B. V. Struminskii (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep.(mn).

The magnetic moments of baryons are obtained using quantum mechanics. The results are compared with those obtained by the SU(6) group. (auth)

16474 (LADC-6291) LOCALIZED GREEN'S FUNCTIONS AND INDEPENDENT-PARTICLE APPROXIMATIONS FOR BOUND SYSTEMS. M. Bolsterli (Los Alamos Scientific Lab., Univ. of California, N. Mex. and Minnesota Univ., Minneapolis). [1962]. Contract W-7405-eng-36. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Localized Green's functions are defined for bound systems. An independent-particle approximation analogous to the Hartree-Fock procedure is derived; the first correction is shown to be identical with that determined in a corresponding shell model. An independent-particle approximation based on use of the free two-particle t matrix instead of the interparticle potential is formulated and its first correction is shown to be similar to that in a suitably constructed shell model. (auth)

16475 (LAL-1109) PHOTOPRODUCTION COHERENTE DES MESONS π^0 SUR LE DEUTERON. (Coherent Photoproduction of π^0 Mesons on Deuterons). Michel Davier, David Benaksas, Darrell Drickey, and Pierre Lehmann (Laboratoire de l'Accélérateur Linéaire, Univ. de Paris, Orsay (France)). July 1964. 86p. Dep.(mn).

The coherent photoproduction of π^0 on the deuteron was studied systematically between the threshold and 300 Mev. The kinematic conditions of the study were given. The theory of π^0 photoproduction is given, and the experimental method is described. The present results and all experimental results available are compared with theory. The final π^0-d interaction decreased significantly the cross sections given by the pulse approximation. For a given transfer this effect is at a maximum at the resonance and minimum at 500 Mev. At 500 Mev the pulse approximation applies only to high transfers. (J.S.R.)

16476 (NP-14680) ETUDE DU SYSTEME DE DEUX NUCLEONS AUX BASSES ENERGIES (THESE). (Study of a System of Two Nucleons at Low Energies (thesis)). Charles-André Héritier (Fribourg Univ. (Switzerland)). 1962. 35p. Dep.(mn).

The excited states of nucleons are considered explicitly based on the Friedman, Lee, and Christian theory. The system of two nucleons is calculated, including the triplet state, the singlet state, and the scattering parameters in the presence of the isobar. The numerical values of the effective range, calculated from the F_k components obtained by variation-iteration, are given for the deuteron and the singlet state. (J.S.R.)

16477 (NP-14827) HIGH-ENERGY π^- + p ELASTIC SCATTERING FOR SMALL MOMENTUM TRANSFERS AND FORWARD DISPERSION CALCULATIONS. Technical Report No. 19. Howard I. Saxer (Michigan Univ., Ann Arbor. Dept. of Physics). Dec. 1964. Contract Nonr-1224(23). 92p.

The negative pion-proton elastic differential cross section was measured at incident pion momenta of 2.01, 3.15, 4.13, and 4.95 Bev/c for the range of the square of the four momentum transfer of $0.0008 \leq |t| \leq 0.154$ $(Bev/c)^2$. The data extended into the region where Coulomb scattering contributions were significant. Experimental values for the real part of the forward nuclear scattering amplitude were calculated using a simple interference model for Coulomb nuclear interaction. The best values found are consistent with dispersion theory predictions in that the sign is negative, indicating destructive interference. Forward dispersion relation calculations were carried out for pion kinetic energies of 1 to 29 Bev using recent $\pi^\pm$ + p total cross section results. (auth)

16478 (NP-14850) REPORT ON RECENT EXPERIMENTAL DATA, 1964. Matscience Report 36. K. Venkatesan (Institute of Mathematical Sciences, Madras (India)). 69p. Dep.(mn).

An experiment at 950 Mev on electron-proton scattering to determine the role of several-photon exchange in such a process, which involves the study of the polarization of the recoil proton, is described. An inconclusive determination of the parity of the $Y_1^*(1660)$ resonance, which seems to favor a P_1 rather than a D_1 assignment, is given. The results of two experiments on pion production in proton-proton collision (with the formation of a deuteron) are given. There seems to be a resonance, as revealed by a sharp peak in the differential cross section at 2.8 Bev/c. An experiment on pion scattering from a polarized proton target is described, and values of the resultant polarization are given. The use of the polarization target technique for other reactions are mentioned. An experiment on the radiative decay of the pion to test non-local effects is quoted. An account of theoretical considerations to determine the intensity of upward muon flux due to cosmic ray neutrinos is given. (auth)

16479 (NYO-3399-09) REDUCTION OF REPRESENTATION OF SU_{mn} WITH RESPECT TO THE SUBGROUP SU_m SU_n. C. R. Hagen (Imperial Coll. of Science and Tech., London, England); and A. J. Macfarlane (Syracuse Univ., N. Y. Dept. of Physics). [1964]. Contract AT (30-1)-3399. 32p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

With a view to application to theories such as the Wigner supermultiplet theory of nuclear structure and its recent extension into the domain of particle physics, the reduction of representations of the special unitary group SU_{mn} into representations of its $SU_m \otimes SU_n$ subgroup is considered. Proof is given of the result, that, in the case of a representation of SU_{mn} of plurality type P_{mn}, this reduction yields only those irreducible representations of $SU_m \otimes SU_n$, whose SU_m and SU_n parts have plurality types P_m and P_n equal to P_{mn} modulo m and modulo n respectively. A practical method of obtaining reductions is described and a tabulation of results in the case of SU_6 and $SU_2 \otimes SU_3$ is made. The method depends on the use of a very concise version of the Weyl character formula for unitary groups which does not seem to have been used elsewhere. (auth)

16480 (NYO-10567) POLARIZATION EFFECTS IN $\pi^- + p \rightarrow \pi^- + p$ AND $p + p \rightarrow \pi^+ + p + n$ AT MODERATELY HIGH ENERGIES (thesis). Peter B. Shaw (Carnegie Inst. of Tech., Pittsburgh, Pa.). Oct. 1963. Contract AT(30-1)-882. 87p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Certain features of recoil polarization in $\pi^- - p$ interactions that do not depend on a detailed phase shift analysis are examined. It is shown how the very special situation of 100% polarization could be expressed by analogy with coplanar forces in equilibrium, and special situations are considered for two and three non-zero amplitudes. Using the principle that small amplitudes do not qualitatively effect the polarization when two overlapping resonances are present, the recoil polarization between two resonances of well defined total angular momenta are examined. It is found that the four possible parity combinations were distinguishable by observing the polarization at two suitable angles. These parity "selection rules" were found to be qualitatively unaltered by the presence of absorption in the resonant states or by the particular "type" of resonance, i.e. Breit-Wigner or Ball-Frazer, with the exception that a Ball-Frazer second resonance (which is assumed to imply a 45° phase difference between resonant amplitudes) resulted in a substantially decreased polarization magnitude at scattering angles less than 90°. The parity assignment of odd and even for the second and third resonances respectively can be made consistent with experimental results by taking the third resonance to have a complicated structure (more than one state), which is also consistent with various theories. The energy dependence of the quantity I.P (which is simpler than that of P) is examined. The simple energy dependence of a Breit-Wigner amplitude is used to point out that I.P does not always peak at the resonance but will peak at an energy that depends solely on the "background" states. It is shown how the parity of a resonance with well-defined total angular momentum can be determined by the change in I.P across the resonance. The assumptions leading to this result were that the background amplitudes, while they may be large, are constant across the resonance and that the real part of the resonant amplitude decreases across the resonance. No assumption is made about the type of resonance. The assumption is also made that amplitudes for orbital angular momentum greater than the resonant angular momentum are negligible. Finally, the reaction $p + p \rightarrow \pi^+ + p + n$ is examined in the model that the principal mechanism involved is the production and subsequent decay of the isobar p^*. A method was given for constructing a non-square production matrix involving a limited number of angular momentum states. By means of the density matrix formalism, the angular distribution and polarization of both the "spectator" neutron and the decay proton from the isobar were calculated, and three possible polarization experiments involving the decay proton were suggested as a means of investigating the spin-spin and spin-orbit interaction in the isobar production process. (auth)

16481 (TID-20444) THE REACTION $K^- + p \rightarrow K + \pi + N$ AT 1.34 Bev/c. J. R. Ficenec, R. I. Hulsizer, W. P. Swanson, and W. P. Trower (Illinois Univ., Urbana. Dept. of Physics). [1963]. Contract AT(11-1)-1195. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Inelastic 2-prong reactions of the type $K^- + p \rightarrow K + \pi + N$ produced by a (1336 ± 47)-Mev/c meson (K^-) beam in the hydrogen bubble chamber were analyzed. Partial cross sections, Dalitz plots, and associated mass histograms for the $K\pi N$ final states are presented. It is apparent the $K^*(888)$ production dominates the reaction in all cases, and $N^*(1238)$ production seems to be present but to a lesser degree. (C.E.S.)

16482 (UCRL-11849) REVIEW OF THE π-NUCLEON EXPERIMENTAL SITUATION AND ITS PHASE SHIFT INTERPRETATION. V. Perez-Mendez and L. David Roper (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 1964. Contract W-7405-eng-48. 23p. (CONF-669-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Conference on Particle Physics, Boulder, Colo., June-July 1964.

A brief review is given of the types of experimental data available for the phase shift analysis of the meson(π)-nucleon interaction up to incident energies of 1 Bev. Total and differential cross sections, polarization of the recoil nucleon, and the rotation and asymmetry parameters are discussed. (C.E.S.)

16483 (UCRL-11866) TWO STUDIES IN POTENTIAL SCATTERING THEORY. I. A GENERALIZATION OF LEVINSON'S THEOREM TO THREE-BODY SYSTEMS. II. A VARIATIONAL METHOD AND EIGENFUNCTION EXPANSION FOR TWO- AND THREE-BODY SYSTEMS (thesis). Jon Alan Wright (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 6, 1965. Contract W-7405-eng-48. 76p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Levinson's theorem is generalized to systems of three particles. The two-body result relates the number of bound states of given angular momentum to the corresponding eigenphase shifts of the S matrix. Because of disconnected diagrams the three-body, S matrix has continuous eigenphase shifts in addition to any discrete ones; however it is possible to define a unitary connected matrix that has only discrete eigenphase shifts. Levinson's theorem is given in terms of these phase shifts, and it is the same as the usual multichannel result, except that there are an infinite number of eigenphase shifts to be summed over for each value of the total angular momentum. The proof is carried out within the framework of the Faddeev equations by generalizing Jauch's proof for two-body systems. A variational principle is developed for finding approximate eigenvalues and eigenfunctions of the kernel of the Lippmann-Schwinger equation. Regge trajectories are then easily found from the solution to the eigenvalue equation. The variational principle is applied to other potential theory calculations with good results in both accuracy and sim-

plicity. The variational principle is extended to the three-body Faddeev equations. (auth)

16484 ON AN ATTEMPT TO REDUCE THE NUMBER OF BASIC CONSTANTS IN ELEMENTARY PARTICLE PHYSICS BY INTRODUCING PSEUDOSCALAR PARAMETERS. PART II. NUCLEAR FORCES. H. Adolf S. Eriksson (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 27: 289-304(1965).

The usual theory of the interaction between a proton and a neutron is generalized by the introduction into the Lagrangian of a new term with a pseudoscalar coupling constant. The usual perturbation method is used, and only the terms bilinear in the coupling constants are considered. The radial differential equations for the two known states of the deuteron are derived. It is shown that the new term gives rise to a spin-independent central potential in the nonrelativistic approximation. The existence of such a potential with its own coupling constant is desirable in a theory of the deuteron since it would account in a natural way for the predominance of the S state in the wave function for the ground state. (auth)

16485 THE SIMPLEST NON-STATIONARY KINETIC EQUATION. V. G. Morozov and S. A. Kholin. At. Energ. (USSR), 18: 62-3(Jan. 1965). (In Russian)

An integrated solution was found for one-velocity kinetic equation in infinite homogeneous media with a two-dimensional or point isotropic source. In the laboratory system the scattering was assumed to be isotropic. The kinetic equation for the particle distribution density for the two-dimensional source is expressed by: $(\partial\psi/\partial t) + v\mu\ (\partial\psi/\partial x) + \beta\psi = (h/2)\int_{-1}^{1}\psi d\mu + (1/2)\,\delta(x)\,\delta(t)$, (where $\beta = 1/l_{tot}$ is the inverse magnitude of the total path, $h = 1/l_j$ is the inverse magnitude of the scattering path: v is the particle velocity; x is the distance to the emitting plane). (R.V.J.)

16486 INTEGRAL EQUATIONS FOR THREE-PARTICLE INTERACTION AMPLITUDES IN THE NON-RELATIVISTIC CASE. V. V. Komarov and Anna M. Popova (Moscow State Univ.). Australian J. Phys., 17: 440-6 (Dec. 1964).

By using the technique of summing an infinite series of non-relativistic graphs, accurate integral equations are obtained for the three-particle interaction amplitudes. (auth)

16487 INELASTIC COLLISIONS FOR SMALL MOMENTUM TRANSFERS. J. Cunningham (University Coll. of North Wales, Bangor, U. K.). Australian J. Phys., 17: 553-5(Dec. 1964).

Inelastic meson(π)-nucleon collisions with small momentum transfers are considered. The analytic properties of the amplitudes are examined as a function of the energy variables. (C.E.S.)

16488 CALCULABLE MODEL FOR A COMPOSITE PARTICLE. DYNAMIC ASPECT. Katsuhiko Sekine (Universite, Paris). Cahiers Phys., 18: 177-88(May 1964). (In French)

The dynamic aspects of the composite particle were analyzed with the aid of a nonrelativistic calculable model. The composite particle is described as an elementary particle by the introduction of operators. The renormalization constant Z of the particle is calculated explicitly. The functional relation between Z and g^2, the renormalized interaction constant, is examined. (tr-auth)

16489 ČERENKOV RADIATION OF PIONS. Charles A. Coombes (Univ. of Alberta, Calgary, Can.). Can. J. Phys., 43: 268-74(Feb. 1965).

The energy radiated by a nucleon as pions in nuclear reactions is calculated by classical methods in the dipole approximation. This leads to a Cherenkov-type radiation of pions. The results are in good agreement with the measured number and spectra of pions in high-energy cosmic-ray events. (auth)

16490 SCATTERING OF A CIRCULARLY POLARIZED PHOTON ON A LONGITUDINALLY POLARIZED PROTON. L. G. Moroz and A. A. Bogush. Dokl. Akad. Nauk Belorussk. SSR, 8: 441-3(1964). (In Russian)

The differential cross section for the scattering of a circularly polarized photon on a longitudinally polarized proton was calculated in the first Born approximation, using a scattering matrix with Pauli interaction. (D.C.W.)

16491 NEW MEASUREMENT OF THE PROTON MAGNETIC MOMENT. B. A. Mamyrin and A. A. Frantsuzov (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 159: 777-8(Dec. 1, 1964). (In Russian)

The cyclotron frequencies of the ions He^+, Ne^{2+}, and Ne^+ were measured with a magnetic-resonance mass spectrometer. At the same time, the frequency of spin precession of hydrogen nuclei in a water sample were measured simultaneously in the same magnet, making it possible to determine the magnetic moment of the proton in nuclear magnetons. The present method makes it possible to measure the cyclotron period of the ions during a single revolution of the ions in the magnetic field to derive from this an exact theory of the motion of the ions in the instrument, and to calculate the cyclotron frequency of the ions on the basis of experimental data without resorting to any supplementary assumptions. In addition, the Faraday number was calculated to be 9,648.03 ± 0.09 Coulomb/mole in the ^{12}C mass scale (against 9,651.42 ± 0.09 in the old physical mass scale). (ATD)

16492 BREMSSTRAHLUNG OF ULTRARELATIVISTIC ELECTRONS IN CONDENSED AMORPHOUS BODIES. V. V. Yakimets. Dokl. Akad. Nauk SSSR, 159: 782-5(Dec. 1, 1964). (In Russian)

A general method previously developed for the determination of the effect of the medium on particle energy losses is generalized quantum-mechanically for a system consisting of the medium, an electron, and an electromagnetic field. The influence of absorption of quanta on the bremsstrahlung of high-energy electrons is evaluated for the case when both the quantum frequency and the initial electron energy are much larger than unity, and account is taken of the multiple scattering and pair production. The calculations make the pair-production cross section frequency-dependent and cause the frequency interval in which absorption is significant to shift strongly towards the classical region, where the frequency is much lower than the initial electron energy. In the quantum-mechanical calculation the differential electron energy losses acquire an additional dependence on the density and the frequency. (ATD)

16493 DETERMINATION OF THE MOMENTUM DISTRIBUTION OF ANNIHILATING ELECTRON-POSITRON PAIRS FROM THE GAMMA-QUANTUM ANGULAR DISTRIBUTION. P. U. Arifov, V. I. Gol'danskii, and Yu. S. Sayasov. Fiz. Tverd. Tela, 6: 3118-23(1964)

It is shown that the formula customarily used to reconstitute the momentum distribution from the γ-quantum angular correlation is based on assumptions that are too approximate. A relation between the density of the momentum distributions of e^+e^- pairs and the coincidence counting rate (as a function of angle) is derived, in which correct account is taken of the geometry of the experiment and of the variability of the probability that the angles of the emitted annihilation γ quanta can be correctly registered by the detectors. The conditions under which the formulas give results that differ appreciably from the old formula are indicated. It is also shown that the formulas can also be used directly to determine the momentum distribution of slow neutral pions from the angular correlation of the γ quanta produced by their decay. (OTS)

16494 SU(3) SYMMETRY SCHEME, A REVIEW. Georges W. London (Univ. of Rochester, N. Y. and Brookhaven National Lab., Upton, N. Y.). Fortschr. Physik, 12: 643-66(1964). (BNL-8375)

The elements of group theory are reviewed, and the isospin group is discussed as an example. Rank two groups in general, SU(3) in particular, are then discussed. The connection to physics is made through the identification of

the basis vectors of the different group representations with physical states. The concept of U-spin is introduced to derive some dynamic predictions of the model. The violation of SU(3) invariance is then discussed. The mass formulas, relating the medium-strong and electromagnetic splittings within a multiplet, are derived to first order. The extension of SU(3) symmetry to weak interactions is briefly discussed. (auth)

16495 HIGH-ENERGY BEHAVIOR OF SCATTERING AMPLITUDE IN THE PERTURBATION THEORY AND IN THE MULTIPERIPHERAL MODEL. G. Sommer (Universitat, Hamburg). Fortschr. Physik, 12: 669-711(1964). (In German)

A review is given of theorems and models for the high-energy behavior of scattering amplitudes. Furthermore, it is shown that the scattering amplitude at extremely high energies cannot be approximated only by the sum of ladder graphs. By substitution of some of the ladder "rungs" by special subgraphs, after summing up a scattering amplitude asymptotically larger than the original one is found. Especially, the sum of all "ladder diagrams with two crossed rungs" exceeds the ladder approximation of the Bethe-Salpeter equation by a factor proportional to the logarithm of the energy. This result is true as well in perturbation theory for A^3-coupling as in the framework of the Amati-Fubini-Stanghellini model. As a consequence asymptotically the total cross section in the multiperipheral model is not given by the imaginary part of the sum of ladder graphs, but all permutations of the multiperipherically produced particles are important at high energies. (auth)

16496 ON THE ANALYTICITY PROPERTIES OF THE SCATTERING AMPLITUDE IN RELATIVISTIC QUANTUM FIELD THEORY. Klaus Hepp (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 37: 639-58(1964).

The analyticity properties of the 2-particle scattering amplitude were rigorously derived in the Wightman framework of a local relativistic field theory. No use was made of the LSZ (Lehmann, Symanzek, and Zimmermann) asymptotic condition and of implicit "technical assumptions." (auth)

16497 SPATIAL CLUSTER DECOMPOSITION PROPERTIES OF THE S-MATRIX. Klaus Hepp (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 37: 659-62(1964).

It is shown that the S-matrix in a local relativistic quantum field theory fulfills the spatial cluster decomposition properties, which were postulated to hold for any reasonable relativistic scattering theory. It is demonstrated that the outcome of a scattering or production process between massive particles is asymptotically independent of the presence of other particles. This justified an expansion of the S-matrix in cluster amplitudes with some analogy to sums of connected Feynman diagrams in perturbation theory. (M.C.G.)

16498 ELECTROMAGNETIC RADIATION, MATTER, AND THEIR INTERACTION. Howard J. Evans (Industrial Nucleonics Corp., Columbus, Ohio). ISA (Instr. Soc. Am.) Trans., 4: 2-16(Jan. 1965).

The various mechanisms are discussed by which electromagnetic radiation interacts with matter. Both the classical and quantum approaches are covered, with an indication to the situations in which each approach is valid. (D.C.W.)

16499 GAMMA RAYS: THEIR NATURE AND USES. Clark Goodman (Houston Research Inst., Tex.). ISA (Instr. Soc. Am.) Trans., 4: 17-25(Jan. 1965).

The nature of gamma rays; instruments which are used to measure the rays; and applications of gamma measurement to well-logging, control of chemical processes, chemical analysis, and aerial surveying are discussed, together with the use of gamma rays in theoretical studies in astronomy. (auth)

16500 USING ELECTROMAGNETIC ENERGY AS A MEASUREMENT TOOL. William L. Adams (Industrial Nucleonics Corp., Columbus, Ohio). ISA (Instr. Soc. Am.) Trans., 4: 26-33(Jan. 1965).

A number of concepts are presented that are common to experiments or equipment which use electromagnetic energy to determine quantities that are not measured directly. The concept of inferential equations is introduced using unique single argument relations and is then expanded to include multi-argument statistical equation sets. The effect of averaging time and scanning window size on the information rate and frequency response is also considered. The limits of precision are discussed with emphasis on the role of the inferential equations. (auth)

16501 PRODUCTION OF ELECTRON POSITRON PAIRS BY A PHOTON IN AN INTENSE ELECTROMAGNETIC FIELD. I. I. Goldman (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 17: No. 5, 93-7(1964). (In Russian)

Inasmuch as perturbation theory is not applicable to pair production at high proton intensity, the exact solution of the Dirac equation in the field of a plane wave is used. The pair production probability is first calculated in general form, after which it is assumed that the wave is monochromatic and the polarization is elliptic. For a plane polarized wave the result agrees with that of H. R. Reiss (Journ. Math. Phys., 3: 59(1962)). For very low photon density in the beam the result goes over into the formula of Breit and Wheeler for pair production in a collision between two photons. By way of an example, it is calculated that in the case of collision of 10-Bev gamma quanta with the beam in a ruby laser the pair production cross section reaches 10^{-32} cm^2. (ATD)

16502 INTERACTING FERMIONS IN ONE DIMENSION. I. REPULSIVE POTENTIAL. J. B. McGuire (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 6: 432-9 (Mar. 1965).

The exact energies and wavefunctions for the ground state and low-lying excited states of a system of N−1 one-dimensional fermions all of the same spin and one fermion of the opposite spin are calculated in the large-volume, finite-density limit when the particles interact via a repulsive delta function potential. A number of properties of the system such as pair correlation functions and the effective mass of a certain class of excitations are also discussed. (auth)

16503 POLES IN FEYNMAN DIAGRAMS WITH SEVERAL LOOPS. Francis R. Halpern and William Wilson (Univ. of California, San Diego, La Jolla). J. Math. Phys. (N. Y.), 6: 463-9(Mar. 1965).

A formula is given that extracts the pole contribution to a Feynman diagram having an internal line. The result is more complicated than earlier results for diagrams with only a single loop since the result is not directly expressible as the pole multiplied by a numerator that is the sum of the reduced diagrams. The apparent discrepancy with Cutkosky's formula for the residue of the pole is reconciled. The algebraic techniques employed are in principle applicable to the problem of determining the Landau surface when the diagram has several loops. A derivation of Stokes' formula for Feynman parametric integrals is given. (auth)

16504 CONSTRUCTION OF THE CHARGE OPERATOR FOR HIGHER SYMMETRY SCHEMES. I. S. Gerstein (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.), 6: 469-73(Mar. 1965).

The problem of the construction of an additively conserved operator with integral eigenvalues, to be identified with the electric charge, is solved in complete generality for the groups locally isomorphic to $U(1) \otimes SU(n)$. It is found that the representations fall into classes on which different charge operators may be defined. Several results previously obtained for particular classes of representations are found here as special cases. The results to N = 4 and several models presently in the literature are discussed. (auth)

16505 CALCULATION OF CERTAIN PHASE-SPACE INTEGRALS. A. Krzywicki (Laboratoire de Physique,

Ecole Polytechnique, Paris and Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 6: 485-7(Mar. 1965).

The result is given of an approximate calculation of the phase-space integral $\Omega_n(Q) = \int \delta_4(Q - \Sigma_i k_i) \prod_i \delta(k_i^2 - \mu_i^2) \vartheta(k_{i0}) f_i(k_{iT})\, d_4k_i$, which appears when one takes into account the fact that only a part of the kinematically allowed phase-space is accessible to particles produced in high-energy collisions, because of the observed smallness of their tranverse momenta. (auth)

16506 COMPOSITE PARTICLES IN A RELATIVISTIC MODEL OF TWO-BODY SCATTERING. L. B. Redei (Univ. of Edinburgh). J. Math. Phys. (N. Y.), 6: 487-92 (Mar. 1965).

The relativistic model of two-particle scattering recently described by Jordan, Macfarlane, and Sudarshan is extended to include bound states. The projection operator associated with the bound-state manifold is explicitly given. This relates the structure of the composite particle to the scattering amplitude. There is a discussion of the conditions the phase shifts have to satisfy in order that they can be fitted with the model. Explicit solutions are derived for a large class of phase shifts. (auth)

16507 FIELDS OF MOVING MULTIPOLES. J. R. Ellis (Bedford Coll., London). Nature, 205: 582(Feb. 6, 1965).

The radiation fields and potentials of moving multipoles were investigated theoretically. (D.C.W.)

16508 THE SEARCH FOR MAGNETICALLY CHARGED PARTICLES. S. Seyfferth (Universitat, Gottingen, Ger.). Naturwissenschaften, 51: 547-50(Dec. 1964). (In German)

The results obtained in the search for magnetically charged particles are briefly reviewed. The properties of these particles—the electrodynamics and quantum mechanics with magnetic charges—are summarized. The experiments performed to detect the particles theorized are indicated. (J.S.R.)

16509 ON BARGMANN-WIGNER THEORY FOR PARTICLES OF SPIN 2. Alberto Vidal (Centro Latino-americano de Fisica and Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro) and S. W. MacDowell. Notas Fis., Centro Brasil. Pesquisas Fis., 10: No. 16, 273-8(1963).

Wave functions are introduced, in terms of which a formulation of the Bargmann-Wigner (BW) theory for spin-2 particles is developed. Covariant tensors are formed from the product of the ten symmetric Dirac matrices and the BW wave function. The force-free wave equations for the wave function are obtained. It is found that the BW theory contains two independent but equivalent theories for spin-2 particles, and that the BW and Fierz-Pauli equations are equivalent for free particles. (M.J.T.)

16510 REPORT ON NON BARYONIC RESONANCES. F. Demay (Princeton Univ., N. J.), W. Vernon, and A. L. L. Videira. Notas Fis., Centro Brasil. Pesquisas Fis., 10: No. 18, 291-328(1963).

Production modes and phenomenological characteristics of the pion resonances—the ρ, ω, and η—and some information on the f^0 and ABC resonances are listed. Various sample mass plots and diagrams of production cross sections are included. Some theoretical considerations on the pion resonances are reviewed. A summary is given of properties of nonbaryonic resonant states with $S \neq 0$, obtained in strong interactions. 112 references. (M.J.T.)

16511 ENERGY AND ANGULAR-MOMENTUM PROPERTIES IN POTENTIAL SCATTERING. V. De Alfaro, E. Predazzi, and C. Rossetti (Universita, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (1), 2: Suppl., 206-33(1964).

Topics on the analyticity properties in the nonrelativistic potential theory, particularly with regard to the analogies and differences between the properties of the scattering amplitude in angular momentum and in linear momentum, are discussed. Well-known techniques and definitions in potential theory are reviewed. The convergence of the Born expansion of the wave function in the configuration and in the momentum space is discussed, and the analytic properties of the partial-wave transition amplitudes are established as a function of energy under suitable assumptions on the potential. The angular momentum representation is considered in order to give perturbative expansions for the asymptotic behavior of the physical quantities in the Re $\lambda \geq 0$ half-plane. The analytic properties in the angular momentum are also discussed. (C.E.S.)

16512 ON THE EQUIVALENCE OF THE MAJORANA AND TWO-COMPONENT THEORIES OF THE NEUTRINO. C. Ryan and S. Okubo (Univ. of Rochester, N. Y.). Nuovo Cimento (1), 2: Suppl., 234-42(1964). (TID-19495)

A proof of the complete equivalence of the two-component (Weyl and Majorana) formulations on the theory of the neutrino is presented. Meson (μ) decay, leptonic decays of strongly interacting particles, and conservation laws in lepton physics are discussed. It is pointed out that in both formulations the neutrino can exist in only two states, one in which its spin is antiparallel to its momentum and one in which it is parallel to its momentum. (C.E.S.)

16513 SINGLE PION PRODUCTION IN π^--p INTERACTIONS AT 2.75 Gev/c. J. P. Baton, A. Berthelot, B. Deler, et al. (CEN, Saclay, France). Nuovo Cimento (10), 35: 713-30(Feb. 1, 1965).

A liquid hydrogen bubble chamber investigation of π^--p interactions was carried out at a momentum of 2.75 Bev/c. 10,645 two-prong events were measured, and the partial cross-sections are: $\sigma_{el} = (7.2 \pm 0.1)$ mb, $\sigma_{p\pi^-\pi^0} = (2.8 \pm 0.1)$ mb, $\sigma_{\pi^-\pi^+n} = (3.9 \pm 0.1)$ mb. In any state of charge, isobar production is very small. π-π mass spectra show a dominant ρ resonance centered at 750 Mev with a full width at half maximum of ≈130 Mev ($\sigma_{\rho^-} = 0.75$ mb, $\sigma_{\rho^0} = 1.1$ mb; for $\Delta^2 \leq 8\ \mu^2$, $\sigma_{\rho^-}/\sigma_{\rho^0} = 1/2$). There is a slight indication of the presence of the f^0 ($\sigma_f \leq 0.1$ mb). Usual tests of the one-pion-exchange mechanism are attempted for the ρ resonances. The π-π elastic cross section and angular distribution are investigated as a function of the π^- incident energy. Finally, the narrow peak in the (π^--π^+) mass spectrum in the region of 780 Mev is discussed. (auth)

16514 STUDY OF YY PRODUCTION IN TWO, THREE AND FOUR FINAL STATES BY 3.0, 3.6, AND 4.0 Gev/c ANTIPROTONS IN HYDROGEN. B. Musgrave, G. Petmezas, L. Riddiford, et al. (Univ. of Birmingham, Eng.). Nuovo Cimento (10), 35: 735-58(Feb. 1, 1965).

The results are presented on hyperon-antihyperon production by 3.0, 3.6, and 4.0 Bev/c antiprotons in hydrogen. About 300,000 pictures taken in an antiproton beam from the CERN proton synchrotron with the 81 cm Saclay hydrogen bubble chamber were used. A systematic study was made of interactions leading to a hyperon and an antihyperon with or without additional pions in the final states. The analysis indicates that the cross sections for each of these processes are of the order of few tens of microbarns or less and that, whereas for the two-body final states the cross sections decrease when the $\bar{p}$ momentum increases from 3.0 to 4.0 Bev/c, the cross sections for 3 and 4 body final states remain constant. For most of these events the angular distributions show a strong forward peaking of the antihyperon in the center of mass system of the interaction. This suggests that a peripheral-type mechanism is predominant in these processes. About half of the events of the type $\bar{p}p \rightarrow Y\bar{Y}\pi$ or $\bar{p}p \rightarrow Y\bar{Y}\pi\pi$ proceed via the formation of hyperon or antihyperon resonances. The $\overline{Y_1^*}(1385)$, $\overline{Y_0^*}(1405)$, $\overline{Y_0^*}(1520)$ resonances and their charge conjugates are produced with masses, widths and decay branching ratios consistent with the values found in other experiments. The cross sections for the reactions $\bar{p}p \rightarrow \Lambda\bar{Y}$ or $\Lambda\overline{Y^*}$ are consistently larger by a factor varying from 2 to 6 than those corresponding to the reactions $\bar{p}p \rightarrow \Sigma^0\bar{Y}$ or $\Sigma^0\overline{Y^*}$. (auth)

16515 π^+ ENERGY SPECTRUM AND BRANCHING OF THE τ' DECAY. V. Bisi, G. Borreani, R. Cester, et al. (Universita, Turin and Istituto Nazionale di Fisica Nu-

cleare, Turin). Nuovo Cimento (10), 35: 768-82(Feb. 1, 1965).

A total of 2027 $K^+ \rightarrow \pi^+\pi^0\pi^0$ decays at rest were analyzed in hydrogen and heavy liquid bubble chambers. The π^+ energy spectrum is compared with 3 spectrum shapes: linear matrix element, linear spectrum, and σ resonance hypothesis. The comparison between τ' and τ decays indicates that they are consistent with I = 1 final state and that the agreement is better if one uses the linear matrix element fit in the τ' decay. The data fit also the σ resonance hypothesis well for $m_\sigma \sim 350$ Mev and $\Gamma_\sigma \sim 80$ Mev, but do not allow a definite conclusion on this point. The τ' to τ branching ratio obtained is 0.303 ± 0.009. (auth)

16516 HARMONICS IN THE SCATTERING OF LIGHT BY BOUND ELECTRONS. L. M. Bali and J. Dutt (Univ. of Lucknow, India). Nuovo Cimento (10), 35: 805-10(Feb. 1, 1965).

Scattering cross sections for monochromatic light scattered by elastically bound electrons into the first and the second harmonics are evaluated. It is found that when the frequency of the incident wave is the same as the natural frequency of the bound electrons, the scattered radiation contains light of not only the resonance frequency, but also of twice that frequency. Moreover, it is shown that resonance can be excited even if the incident light is of half the natural frequency, ω_0; the observed radiation will then consist of frequencies ω_0 and $\omega_0/2$. The cross-sections for these effects depend on the intensity of the incident light, but, because of resonance, one does not require light of extraordinary intensity for their observation, light sources, such as commonly used in resonance radiation experiments, should suffice. (auth)

16517 A PHENOMENOLOGICAL MODEL APPLIED TO K^+-Σ^0 PHOTOPRODUCTION. J. Dufour (Universite de Paris, Orsay, France). Nuovo Cimento (10), 35: 860-6 (Feb. 1, 1965).

A phenomenological model analogous to that used for the $\gamma + p \rightarrow K^+ + \Lambda$ interaction is applied to the $\gamma + p \rightarrow K^+ + \Sigma^0$ interaction. It includes Born terms, the meson (K^*), and the first N^* isobar. The results are compared to those obtained for the $\gamma + p \rightarrow K^+ + \Lambda$ interaction and are discussed in view of the predictions of unitary symmetry. (tr-auth)

16518 LOW ENERGY p-WAVE Λ-π PHASE SHIFTS IN $J = 1/2$ AND $T = 1$ STATE. R. Nath and A. Kumar (Univ. of Delhi). Nuovo Cimento (10), 35: 872-8(Feb. 1, 1965).

The low-energy p-wave Λ-π phase shifts were calculated in $J = 1/2$ and $T = 1$ state using a Khuri-Udgaonkar representation which was modified in such a way as to display explicitly in the $z(= \cos\theta)$-plane, apart from the right-hand π-π cut and the left-hand Λ-π cut, the isolated Σ-pole and Y_1^* resonance pole occurring in the u-channel. The results obtained were compared with those obtained from the original Khuri-Udgaonkar representation. (auth)

16519 SINGULAR POTENTIALS WITH SHORT RANGE. H. Cornille and E. Predazzi (CERN, Geneva). Nuovo Cimento (10), 35: 879-912(Feb. 1, 1965).

Previous works showed the properties and the possibility of useful approximate methods for the Jost functions, and the radial wave functions in the case of Yukawa generalized potentials, less or equally singular than the centrifugal term. Some of these results are extended to a larger class of short-range potentials which, near the origin, can be represented as a finite superposition of inverse powers of the radial variable; namely, the most singular term is repulsive with an arbitrary inverse-power behavior. For simplicity, the degrees of the other terms are obtained from one of the leading terms by the decreasing of unities. The key (as for the inverse power-square case) is to find a singular factor removing the singular part near the origin of the outgoing (ingoing) waves, and keeping unaltered the asymptotic character of the outgoing (ingoing) waves. After this, the analysis follows, as closely as possible, the usual development. By investigating the asymptotic behavior of the Laplace transform, the existence of the Jost function is proved. The definition of the Jost function as a series, whose p-th term comes from the contribution of the iteration of order p of the inverse Laplace transform, is divergent. A method is presented for evaluating the Jost function by means of convergent sequences, which allow the calculation of approximations which are always convergent without any arbitrary cut-off or hard-core procedures. All the above formalism is given for the l = 0 case. (auth)

16520 SINGULAR INTEGRAL EQUATIONS IN THE BOUND-STATE PROBLEM. G. Cosenza, L. Sertorio, and M. Toller (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 35: 913-32 (Feb. 1, 1965).

The Bethe-Salpeter equation is investigated when its kernel does not satisfy the Fredholm conditions, but corresponds to a bounded operator. Under this condition the mathematical basis is given for the study of the analytic properties of the bound-state condition in terms of the parameters which appear in the integral equation. The application of the general method to the particular case of the interaction of two scalar mesons through the exchange of a vector meson is shown in detail. (auth)

16521 REMARKS ON TRIPLET MODELS IN SU_3 SYMMETRY. T. D. Lee (CERN, Geneva). Nuovo Cimento (10), 35: 933-44(Feb. 1, 1965). (TID-21173)

Assuming that the charges of all particles are integral multiples of the same unit and that all known strongly interacting particles can be regarded as composites of two basic particles, a triplet alpha and a singlet (or a triplet) beta, through their strong interactions which are approximately SU_3-invariant, many different models can be constructed. It is shown that from a phenomenological point of view, all these models can be regarded as equivalent to each other. The stability question whether a single alpha is stable against decay into known particles is studied. The stability of alpha holds if the baryon number of proton is three times that of alpha. Alternative reasons for expecting stability of alpha, that are independent of its baryon number assignment, are presented. Speculations connecting the possible existence of such stable particles in the universe and the many recently observed violent outbursts in various galaxies are outlined. (auth)

16522 SYMMETRY PROPERTIES OF LEPTONS IN THE ZERO-MASS LIMIT. T. D. Lee (CERN, Geneva). Nuovo Cimento (10), 35: 945-55(Feb. 1, 1965). (TID-21175)

The symmetry properties of all known leptons are studied for those processes in which their mass differences can be neglected. It is found that in this approximation both the electromagnetic interaction H_{elect} and the weak interaction H_{weak} are invariant under a $U_2 \times U_2$ group of transformations. Thus, in the zero-mass limit, all lepton systems are characterized by six quantum numbers (in addition to charge, momentum, etc.). The electromagnetic interaction is known to be further invariant under a discrete symmetry operator C (charge conjugation), or P (parity). It is proposed that the weak interaction is also invariant under a discrete symmetry operator, called D, which exchanges charged leptons and neutral leptons. The C symmetry is violated by H_{elect}, and the D symmetry is violated by H_{weak} and by the mass differences. Applications of these symmetry properties to high-energy lepton reactions are discussed. (auth)

16523 BRANCHING RATIO AND FORM OF INTERACTION FOR THE β-DECAY OF THE Λ-HYPERON. C. Baglin (Ecole Polytechnique, Paris), V. Brisson, A. Rousset et al. Nuovo Cimento (10), 35: 977-87(Feb. 16, 1965).

Events (102) of the decay $\Lambda \rightarrow p + e^- + \nu$ were found among 218000 photos taken with a 17-kgauss heavy liquid bubble chamber in a 1.45 Bev/c K^- beam (<2% π^-). The liquid was C_2F_5Cl with a density of 1.2 g/cm^3 and a radiation length of 25 cm, giving ~87% electron detection efficiency and stopping ~85% of protons from $\Lambda \rightarrow p + e^- + \nu$. The branching ratio $(\Lambda \rightarrow p + e^- + \nu)/(\text{all } \Lambda)$ is found to be $(0.78 \pm 0.12) \cdot 10^{-3}$ in agreement with previous results. The proton transverse momentum (and proton kinetic energy in the Λ rest system) spectra, and the e-ν correlation are

incompatible (< 1% probability) with those expected for either pure vector or pure scalar $\Lambda \to p + e^- + \nu$ interaction. Pure tensor or pure axial vector are less probable than V + A, but are not excluded by the data. Assuming a V and A theory with two form factors independent of the momentum transfer, the best fit is for $|C_V/C_A| = 0.8^{+\infty}_{-0.8}$ and with 95% confidence $0 < |C_V/C_A| < 3$. Since the Λ's are unpolarized, there are too few events to determine the sign of C_V/C_A. (auth)

16524 MEASUREMENTS ON THE MUON FLUX AT VARIOUS ZENITH ANGLES. R. J. R. Judge and W. F. Nash (Nottingham Univ., Eng.). Nuovo Cimento (10), 35: 999-1024(Feb. 16, 1965).

The momentum spectra of muons arriving at zenith angles of 30, 45 and 60° in the East-West azimuth were determined at Nottingham (latitude 53°N) using a Conversi tube spectrograph. It is shown that a pion production spectrum of the form $N(p_\pi)dp_\pi = 0.373p_\pi^{-2.91}dp_\pi$ generates the spectra. The variations of the sea-level muon charge ratio at the angles considered and of the exponent n in the expression $I_\theta = I_0 \cos^n \theta$ with momentum were also determined. (auth)

16525 THE SPECTRUM OF MUONS ARRIVING AT LARGE ZENITH ANGLES. R. J. R. Judge and W. F. Nash (Nottingham Univ., Eng.). Nuovo Cimento (10), 35: 1025-30(Feb. 16, 1965).

The momentum spectrum of muons arriving at sea-level at zenith angles between 83 and 90° was determined using the Nottingham spectrograph. Using the measured 30° spectrum, pion and kaon production spectra were determined assuming either all-pion or all $K_{\mu 2}$ parentage of sea-level muons. It is estimated that the kaon contribution to the sea-level muon flux for muon production momenta in the range from 40 to 100 Bev/c is not more than about 30%. (auth)

16526 PRODUCTION OF NUCLEON ISOBARS BY 7.1 Gev/c PROTONS. C. M. Ankenbrandt, A. R. Clyde, Bruce Cork, D. Keefe, L. T. Kerth, W. M. Layson, and W. A. Wenzel (Univ. of California, Berkeley). Nuovo Cimento (10), 35: 1052-60(Feb. 16, 1965). (UCRL-11423(Rev.))

The missing mass spectrum of nucleon isobars produced in the reaction $p + p \to N^* + p$ by 7.1-Bev/c protons incident on a liquid hydrogen target was measured. Scintillation counters detected the recoil protons after momentum analysis. Cross sections were obtained for production of isobars of mass 1238, 1512 and 1688 Mev at momentum transfers of 0.09, 0.15, 0.24, 0.33, and about 5 $(Bev)^2$. At low momentum transfers, the spectrum has additional structure at a mass of about 1430 Mev. The T = ½ isobar production cross sections at $|t| = 5(Bev)^2$ are comparable with the elastic scattering cross section. (auth)

16527 ON THE Λ^0 β-DECAY. M. Lacombe (Universite de Paris, Orsay, France), R. Pasquier, and R. Vinh Mau. Nuovo Cimento (10), 35: 1061-8(Feb. 16, 1965).

The electron-antineutrino angular correlation, the transverse electron-antineutrino angular correlation, and antineutrino energy spectrum were calculated using various forms of the Λ-p-e-ν interaction. (D.C.W.)

16528 HIGH-ENERGY PION-NUCLEON CHARGE-EXCHANGE SCATTERING AND THE ρ-MESON TRAJECTORY. H. A. Rashid (Technische Hochschule, Karlsruhe, Ger.) and N. Zovko. Nuovo Cimento (10), 35: 1069-76 (Feb. 16, 1965).

The method proposed by Frazer for calculating the parameters of the Regge pole trajectories is applied to the π-N charge-exchange process at high energy which is dominated by the meson (ρ) exchange. The value of $\alpha_\rho(0)$, the position of the ρ-trajectory at zero energy calculated by this method, is consistent with that obtained recently from forward dispersion relations and Reggeized parametrization of total cross sections at high-energies. The calculated differential cross section for the charge exchange process in the forward direction is compared with the available experimental data, and the recent result from CERN on the charge-exchange process is analyzed in order to obtain a value for the slope of the trajectory. (auth)

16529 DEUTERON ELECTROMAGNETIC FORM FACTORS. [PART] II. M. Gourdin (Stanford Univ., Calif.). Nuovo Cimento (10), 35: 1105-13(Feb. 16, 1965).

The corrections to the electromagnetic form factors of the deuteron due to the momentum of the spectator nucleon are calculated, using the impulse approximation for the deuteron in the Breit system. (D.C.W.)

16530 NEUTRINO PRODUCTION OF PION PAIRS. G. Karpman (Universita, Florence). Nuovo Cimento (10), 35: 1114-21(Feb. 16, 1965).

Using a relativistic Weizsäcker-Williams method, the total cross section of the process $\nu_\mu + Pb \to Pb + \pi^+ + \pi^0 + \mu^-$ was calculated, assuming the CVC hypothesis. It was further shown that, in the present experimental conditions, the argument of Treiman and Yang can be extended to provide a test for the model with single-photon exchange. (auth)

16531 HARD-PHOTON EMISSION IN THE COLLIDING BEAM REACTION $e^+ + e^- \to \mu^+ + \mu^-$. Nuovo Cimento (10), 35: 1122-37(Feb. 16, 1965).

The correction due to emission of hard photons from the final particles in the reaction $e^+ + e^- \to \mu^+ + \mu^-$ is evaluated to the lowest order. This correction and the corresponding radiative corrections to the final vertex reduce the total cross section corrected to the same order in the initial vertex by about 30% when the total energy in the center of mass system is 500 Mev. (auth)

16532 ON THE ANALYTICITY OF THE S-MATRIX IN POTENTIAL SCATTERING. J. S. Muldowney (Univ. of Alberta, Edmonton). Nuovo Cimento (10), 35: 1138-52 (Feb. 16, 1965).

The S-matrix is shown to be an analytic function in the topological product of the λ and k planes for any piecewise continuous central potential V(r), such that $|V(r)| \leq M_1/r^{2-\delta}$, $\delta > 0$ as $r \to 0$, and $|V(r)| \leq M_2/r^{1+\gamma}$, $\gamma > 0$ as $r \to \infty$. (auth)

16533 NONLOCAL FORM FACTORS FOR HIGH-ENERGY PROTON-PROTON SCATTERING AT LARGE MOMENTUM TRANSFER. V. Wataghin (Universita, Turin and Istituto Nazionale di Fisica Nucleare, Turin) and H. R. Reiss. Nuovo Cimento (10), 35: 1153-9(Feb. 16, 1965).

A nonlocal field-theoretical model, in which a well defined choice of form factors is made, is applied to high-energy proton-proton elastic scattering. Only the exchange of strongly interacting mesons and this only in the lowest order of perturbation theory, is taken into account. The form factors are functions of the total center of mass energy squared s and momentum transfer squared t, and their s and t dependence is almost, but not completely, fixed by the requirements of relativistic invariance and macroscopic causality. At high s and t values they probably reduce considerably the contribution of higher-order diagrams. A comparison with the existing experimental data is made. All the qualitative features of the data are reproduced, while the quantitative fit is good only in a limited range of values of t. (auth)

16534 THE SCATTERING OF PHOTONS BY PHOTONS. B. De Tollis (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 35: 1182-93 (Feb. 16, 1965).

The general expressions for the five independent amplitudes of photon-photon scattering are given in a rather compact form. It was previously shown that this result is easily obtained for all the values of the energy and of the angle with the aid of the dispersion relations techniques. In that paper one particular amplitude was calculated using the double-dispersive representation and the Cutkosky rules for the calculation of the spectral functions at the lowest perturbative order. The knowledge of the amplitudes for any value of the angle enables one to make the numerical evaluation of the total cross section. The curve of the

total cross section as a function of the energy for unpolarized photons is given. The maximum of the total cross section ($\approx 1{,}6\ \mu b$) is reached when the energy of each photon is about 0.7 Mev in the center-of-mass system. Angular distributions for unpolarized as well as polarized photons are given. (auth)

16535 STATISTICAL THEORY OF ELASTIC PROTON-PROTON SCATTERING AT LARGE ANGLES. A. Bialas and V. F. Weisskopf (CERN, Geneva). Nuovo Cimento (10), 35: 1211-24(Feb. 16, 1965).

It is assumed that the collision of two nucleons of high energy sometimes forms a "compound system" in thermal equilibrium. The secondary processes following the collision are then the decay products of this compound system. It is conjectured that the elastic scattering at large angles is primarily due to this mechanism. Its cross section can then be calculated by simple thermodynamical methods. The pion cloud in the compound system is approximated by a massless boson gas. The Stefan-Boltzmann equation leads to an exponential energy dependence $\exp[-E/T]$ of the cross-section with $T \sim E^{\frac{1}{4}}$, where E is the kinetic energy of the nucleons. The order of magnitude of the cross section can also be estimated. These results agree with the experimental observations and with previously published computer calculations of the relevant phase space by Fast and Hagedorn and by Jones. (auth)

16536 ON THE POSSIBILITY OF CP VIOLATION IN THE $K \rightarrow 3\pi$ DECAY. M. K. Gaillard (Université de Paris, Orsay, France). Nuovo Cimento (10), 35: 1225-30(Feb. 16, 1965).

The possibility of a large CP violation in $K \rightarrow 3\pi$ decays is investigated. (D.C.W.)

16537 POSSIBLE TESTS OF UNITARY SYMMETRY IN REACTIONS WITH DEUTERON TARGETS. G. Costa and R. Santangelo (Istituto di Fisica "Galileo Galilei", Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 35: 1251-3(Feb. 16, 1965).

Relations among the amplitudes for deuteron interactions are presented, by which SU_3 symmetry can be tested. (D.C.W.)

16538 DYNAMICAL MODEL FOR A RESONANCE WITH NON-UNIQUE ANGULAR MOMENTUM. H. Goldberg (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 36: 94-9(Mar. 1, 1965).

A model is presented in which the forces due to the presence of an inelastic channel with several spin degrees of freedom cause two different partial-wave phase shifts to go through 90° at the same energy, while a third partial-wave amplitude goes through resonance at two distinct energies. All the resonances occur below the inelastic threshold. (auth)

16539 ON THE WAVE OPERATORS FOR SCATTERING ON STRONGLY SINGULAR AND NOT SPHERICALLY SYMMETRIC POTENTIALS. N. Limic (Inst. "Rudjer Boskovic," Zagreb). Nuovo Cimento (10), 36: 100-8 (Mar. 1, 1965).

The existence of the wave operators for the scattering on strongly singular potentials that are not spherically symmetric and that decrease faster than the inverse cube potential at infinity is shown. (auth)

16540 ON SCALAR $K\pi$ RESONANCES. K. Raman (Matscience, Inst. of Mathematical Sciences, Madras). Nuovo Cimento (10), 36: 115-19(Mar. 1, 1965).

The possibility of scalar $K\pi$ resonances is examined in a model in which the forces are approximated by poles in the lowest partial waves in the crossed channels. It is found that in both the $I = \frac{1}{2}$ and $I = \frac{3}{2}$ channels, the resonance obtained with the simple model has too large a width; the reasons for this are analyzed. It is necessary to have more attractive forces and forces which vary more rapidly with energy in order to obtain narrow resonances. (auth)

16541 SINGLE-PARTICLE-EXCHANGE MODEL FOR HYPERNUCLEAR FORCES. B. W. Downs (Oxford Univ. and Atomic Energy Research Establishment, Harwell, Berks, Eng.) and R. J. N. Phillips. Nuovo Cimento (10), 36: 120-8(Mar. 1, 1965).

A model for the Λ-Λ and Λ-Λ potentials is presented, based on the exchange of η, K, ω, K*, and a phenomenological scalar meson S. The S coupling is adjusted empirically, but other couplings are fixed by unitary symmetry and by comparison with the Λ-Λ problem. The model gives a reasonable fit to most of the data. (auth)

16542 ELECTROMAGNETIC FORM FACTORS. M. Gourdin (Stanford Univ., Calif.). Nuovo Cimento (10), 36: 129-49(Mar. 1, 1965).

The matrix elements of the electromagnetic current for a particle of spin J are investigated. The main difficulties of the covariant approach are due to the complicated connection between the spin and the irreducible representation of the homogeneous Lorentz group. The Breit system is introduced, and, by means of a special Lorentz transformation along the transfer momentum, the matrix elements of the electromagnetic current in the rest system is written as a $(2J + 1) \times (2J + 1)$ matrix in the helicity space. The physical form factors are defined by expanding the matrix elements in irreducible tensors according to the properties of the electric and magnetic multipole moments. The density matrix for a polarized recoil particle is studied. The particular case of a spin $J = \frac{3}{2}$ particle is treated, and a complete expression of the density matrix is given. (C.E.S.)

16543 RECONSIDERATION OF THE COLLISION MODEL PROPOSED BY BHATNAGAR, GROSS AND KROOK. T. Koga (Polytechnic Inst. of Brooklyn). Nuovo Cimento (10), 36: 174-88(Mar. 1, 1965).

The collision model proposed initially by Bhatnagar et al. is reformulated so that the model is valid for a system of particles of more than one species. The case of binary interaction is considered. An attempt is made to consider the collision cross section of two colliding particles as a function of the relative velocity. The formulation of multiple interaction is also considered. The significant difference between binary interaction and multiple interaction is demonstrated by the difference of the momentum and energy relations in these two cases. (auth)

16544 ONE-MESON-EXCHANGE CONTRIBUTION TO Λ-Λ SCATTERING. G. Alexander (Weizmann Inst. of Science, Rehovoth, Israel), A. Fridman, and E. Gotsman. Nuovo Cimento (10), 36: 189-98(Mar. 1, 1965).

The one-meson-exchange contribution to the differential and total cross section was calculated for Λ-p scattering using the one-pole approximation for K, η, K*, and ω exchange. The coupling constants were chosen both from experimental data and SU_3 model. Results indicate that the K* exchange is the dominating process at incident momenta (0.5 to 3.0) Bev/c, and is in agreement with the experimental results of about 20 mb at 0.5 Bev/c. (auth)

16545 BOSON LEVELS AND COMPOSITE MODEL IN U_4 SYMMETRY. S. Furui (Ibaraki Univ., Mito, Japan), S. Furuichi, M. Sawamura, M. Imoto, S. Ishida, and S. Kawasaki. Nuovo Cimento (10), 36: 206-14(Mar. 1, 1965).

Following the extended Sakata model where the four fundamental ur-baryons are introduced, the approximate U_4 symmetry is assumed, and the mass splitting of bosons which comes from the mass differences of ur-baryons in the model is investigated. Several relations among masses of both known and unknown bosons are obtained. (auth)

16546 RADIATIVE CHARGED LEPTON PRODUCTION BY NEUTRINOS. J. Lovseth and J. D. Walecka (CERN, Geneva). Nuovo Cimento (10), 36: 236-49(Mar. 1, 1965).

The cross section for production of high-energy photons from the reaction $\nu_l + n \rightarrow l^- + \gamma + p$ was calculated. The calculation is made for point weak interactions and then the structure effects of the strong interactions on the form factors are included in two different ways: first by simply multiplying the point amplitude by an appropriate form factor and then by making a model of the form factors and at-

tributing them to meson exchanges. The results for the ratio of the radiative to the elastic cross section are relatively insensitive to the different approximations. Numerical results are given for photon spectra and integrated cross sections in the case of incident ν_μ. The cross section for production of a photon with energy greater than 100 Mev is about 1.5% of the elastic cross section when averaged over the CERN neutrino spectrum, and about 0.4% for photons with energy greater than 500 Mev. (auth)

16547 SINGULARITIES IN COMPLEX ANGULAR MOMENTUM ASSOCIATED WITH NONPLANAR KERNELS. A. P. Contogouris (Nuclear Research Center "Democritus," Athens and Center for Advanced Study in Physics, Athens). Nuovo Cimento (10), 36: 250-69(Mar. 1, 1965).

The Bethe-Salpeter equation generated by a unit nonplanar graph (with two crossed lines) is studied in two cases of scattering of spinless bosons: I) via a φ^3 interaction and II) through vector meson exchange. In case I), when a_i(i = 1, 2, 3, 4) are the Feynman parameters assigned to this graph, a general proof is given that the totality of the contributions to $f(a) = a_1a_2 - a_3a_4 = 0$ from the interior of the a-space can be associated with a singular potential which generates a Gribov-Pomeranchuk accumulation point of even signature amplitude at $l = -1$. On the other hand, the contributions to f(a) = 0 from the edges of the a-space are shown to generate a set of moving poles in complex l; certain properties of the corresponding trajectories are established. In case II) a similar procedure allows the definition of a singular potential in terms of the contributions of f(a) = 0. It is shown that certain parts of this potential can be connected with spin-type translations of a Gribov-Pomeranchuk singularity to l = 1, but that the complete contribution is regular at this point. Finally, the contributions from $f(a) \neq 0$ are considered; for a simplified (but characteristic) form it is shown that, in the weak-coupling limit, they generate a square-root-type fixed branch point near the origin of the complex angular momentum plane. (auth)

16548 LOW-ENERGY Λ-NUCLEON SCATTERING. Guru Vachan Dass (Univ. of Delhi). Nuovo Cimento (10), 36: 270-4(Mar. 1, 1965).

A N/D calculation of low-energy elastic Λ-N scattering is reported. The channel $\Lambda + N \rightarrow \Sigma + N$, which has a threshold at about 170 Mev, is neglected. The forces responsible for the interaction were assumed to be caused by the exchange of the possible scalar, pseudoscalar, and vector mesons in the crossed channels. The exchanged particles considered are the σ(395 Mev), the η(549 Mev), the φ(1020 Mev), and the ω(783 Mev) in the t channel and the κ(725 Mev), the K(495 Mev), and the K*(891 Mev) in the u channel. (C.E.S.)

16549 USE OF A POLARIZED PROTON TARGET FOR THE DETERMINATION OF THE PARITIES OF MULTIBOSON RESONANCES. S. Barshay (Princeton Univ., N. J. and Rutgers Univ., New Brunswick, N. J.). Nuovo Cimento (10), 36: 275-6(Mar. 1, 1965). (PPAD-520-E)

A particularly powerful use of a polarized proton target in the determination of the parities of resonant states which decay strongly into bosons is pointed out. The method allows a parity determination independent of the spin of the resonant bosonic state. A reaction on a polarized proton target of the type $A + p \rightarrow B + Y$, where A is a boson with spin-parity 0^-, B is a bosonic resonant state with spin-parity J^P, and Y is a spin-½ hyperon which decays with parity nonconservation into a spin-zero boson and a spin-½ fermion is considered. (C.E.S.)

16550 RADIATIVE DECAY OF X-MESON. S. K. Kundu and D. C. Peaslee (Australian National Univ., Canberra). Nuovo Cimento (10), 36: 277-8(Mar. 1, 1965).

The assignment of the quantum number A, characteristic of bosons, is considered for the meson (X) (960 Mev), and an assignment of A = +1 is made. This implies certain features for the radiative decay of the X that might possibly be exploited in deciding between the two most likely spin and parity choices $J^P = 0^-$ and 1^+. These features are discussed. (C.E.S.)

16551 SELF-CONSISTENT DETERMINATION OF ρ-MESON PARAMETERS IN THE COUPLED $\pi\pi$-$K\bar{K}$ PROBLEM. Ravinder Nath (Univ. of Delhi). Nuovo Cimento (10), 36: 284-6(Mar. 1, 1965).

A self-consistent calculation of meson (ρ) parameters in the coupled $\pi\pi$,$K\bar{K}$ problem is presented, using the experimental values of π, K, K*, and φ masses and assuming all the coupling constants that enter into the problem to be related to the $\rho\pi\pi$ coupling constant by SU_3. (C.E.S.)

16552 THE COMPOSITE ρ-MESON COUPLING CONSTANT IN THE H AND X MODELS. G. Clement, A. Jacquemin, and B. Jouvet (Universite, Paris). Nuovo Cimento (10), 36: 287-90(Mar. 1, 1965).

An attempt is made to obtain a sensible function which explains the magnitude of g^2 (g is the $\rho\pi\pi$ coupling constant). Two different classes of interactions that may bind particles together, called H and X, were investigated. The H interactions are those resulting from the essentially nonlocal exchange of some meson between the pions, and the X interactions are those which postulate the existence of some local attractive bare coupling between the pion currents (Fermi-type coupling). (C.E.S.)

16553 MULTIPLE-CHANNEL BOOTSTRAP. G. Mohan and N. K. Tyagi (National Physical Lab., New Delhi, India). Nuovo Cimento (10), 36: 291-3(Mar. 1, 1965).

A simple approach to the multichannel bootstrap procedure for scattering calculations based on a generalization of the Fredholm solution is presented. (C.E.S.)

16554 QUASI-CLASSICAL APPROXIMATION FOR THE PHASES OF SCATTERING. G. V. Dubrovskii. Opt. Spectry. (USSR) (English Transl.), 17: 416-18(Nov. 1964). Translated from Optika i Spektroskopiya, 17: 771-5(Nov. 1964).

The quasi-classical approximation was used to solve the problem of elastic scattering of particles in a potential field in which quasi-stationary states are possible for smooth potentials. The relationship between the behavior of the phases for small energies and the number of quasi-stationary states was established. As an example, the behavior of s and p phases of electron scattering in the static field of a hydrogen atom was calculated. (auth)

16555 PHOTOPION PRODUCTION FROM DEUTERIUM NEAR THRESHOLD. William P. Swanson, Duane C. Gates, Thomas L. Jenkins, and Robert W. Kenney (Univ. of California, Berkeley). Phys. Rev., 137: B1188-1201(Mar. 8, 1965). (UCRL-11587)

The interactions γ-d → π^--2p and π^+-2n were studied near threshold. A 4-in. liquid-deuterium bubble chamber served as target and detector in a 194-Mev bremsstrahlung beam hardened by about one radiation length of LiH. A total of 1309 π^- and 447 π^+ events was analyzed. The experimental data for the minus-to-plus ratio R were corrected for final-state Coulomb interactions by the method of Baldin, with the results $R = 1.28 \pm 0.13$ for 160 Mev < k < 175 Mev and $\theta^* > 110$ deg (c.m.); $R \geq 1.13 \pm 0.13$ for 152 Mev < k < 160 Mev and $\theta^* < 110$ deg (c.m.). The theory of Chew, Goldberger, Low and Nambu (CGLN), modified by Ball to include the ρ-exchange parameter Λ, predicts $R = 1.28(1 - 0.14\ \Lambda/e)$. This relation was used with our values of R to obtain $\Lambda/e = 0.0 \pm 0.7$ and $\Lambda/e \leq 0.8 \pm 0.7$ for the above two photon-energy ranges. The Chew-Low extrapolation technique was used to obtain the value of the squared matrix element a_0^- for the reaction γ-n → π^--p. It was found to be a satisfactory method to apply to the deuteron for deriving reaction cross sections for free neutrons. $a_0^- = 27.3 \pm 2.8$ μb/sr was obtained at threshold with a slope of -0.30 ± 0.16 μb/sr Mev. The most accurate value is $a_0^- = 23.3 \pm 1.9$ μb/sr at $k_{\gamma n} = 162$ Mev. These results have been corrected for the final-state π^--p interaction, by means of the Coulomb penetration factor. The threshold value of the squared matrix element for the reaction γ-p → π^+-n was determined to be $a_0^+ = 21.5 \pm 0.9$ μb/sr by McPherson using the same apparatus. Combining these results gives the values $R = a_0^-/a_0^+ = 1.27 \pm 0.13$ at threshold and $\Lambda/e = 0.06 \pm 0.7$. The results are in good agreement with the CGLN theory, and are consistent with a value Λ = 0. (auth)

16556 DEPARTURES FROM THE EIGHTFOLD WAY. III. PSEUDOSCALAR-MESON ELECTROMAGNETIC MASSES. Robert H. Socolow (Univ. of California, Berkeley). Phys. Rev., 137: B1221-8(Mar. 8, 1965).

The leading contributions to the π^+-π^0 and K^+-K^0 mass differences are calculated. The contributions of pseudoscalar-meson and vector-meson intermediate states are considered, and the Feynman integrations are performed assuming very general momentum dependence at the vertices. Using form factors having poles at the vector-meson masses, and the unitary-symmetric vector mixing model of Coleman and Schnitzer, $m_{\pi^+} - m_{\pi^0} = 4.9$ Mev and $m_K^+ - m_K^0 = 2.9$ Mev are obtained. The uncertainty lies partly in the determination of the γ-ρ-π coupling constant and partly in the dynamical assumptions. When the scalar-meson contribution suggested by Coleman and Glashow is included, the meson (π) mass difference is unchanged and the meson (K) mass difference becomes $m_K^+ - m_K^0 = -1.4$ Mev. (auth)

16557 RESONANCE MODEL FOR Σ^+-K^+ PRODUCTION. L. E. Evans and J. M. Knight (Duke Univ., Durham, N. C.). Phys. Rev., 137: B1232-5(Mar. 8, 1965).

A model for the process $\pi^+ + p \rightarrow \Sigma^+ + K^+$ is proposed, consisting of hyperon- and K*-exchange diagrams as well as the $p_{\frac{3}{2}}$ resonance and a resonance of 1940 Mev, assumed to be $f_{\frac{5}{2}}$. The resulting four-parameter fit is compared with the cross-section, angular distribution, and polarization data at beam momenta from 1.04 to 1.76 Bev/c. (auth)

16558 THE EQUIVALENCE OF ELEMENTARY AND COMPOSITE PARTICLES. M. A. Nagarajan and W. Tobocman (Case Inst. of Tech., Cleveland). Phys. Rev., 137: B1236-9(Mar. 8, 1965).

Given the Hamiltonian density of a system of interacting fields, it is possible to specify a second system which differs from the first by having one more or one less field in the Hamiltonian density and which has the interaction terms of the Hamiltonian density so modified that the physical properties of the two systems are the same. It follows that certain single-particle states of one system that are regarded as elementary-particle states must be present in the other system as composite-particle states. The connection between such physically equivalent systems is derived. The formalism is applied to the Lee model and the extended Lee model. (auth)

16559 PS_8-PS_8-V_8 COUPLING CONSTANTS WITH BROKEN SYMMETRIES. Jose R. Fulco (Univ. of California, Santa Barbara) and David Y. Wong. Phys. Rev., 137: B1239-41(Mar. 8, 1965).

The effect of the mass splitting of the pseudoscalar octet on the PS_8-PS_8-V_8 coupling constants and on the splitting of the vector octet is investigated using a simple effective range formula for the coupling of a vector to two pseudoscalars with the potential produced by the exchange of the vector mesons. It is found that the deviation of the coupling constants from SU_3 symmetry is less than 3%, but the splitting of the vector masses is of the order of 10 to 30%. The results show a better agreement with experiment than obtained in an earlier calculation which did not consider the breaking of the coupling constants. (auth)

16560 EFFECT OF CLOSED INELASTIC CHANNELS ON THE WIDTH OF RESONANCES. Jose R. Fulco (Univ. of California, Santa Barbara), Gordon L. Shaw, and David Y. Wong. Phys. Rev., 137: B1242-9(Mar. 8, 1965).

The effects of including nearby inelastic channels are examined on three separate examples of p-wave resonances: a three-channel ($\pi\pi$, $\pi\omega$, $K\bar{K}$) system is treated in a calculation of the ρ (760 Mev) resonance, a two-channel (πK, ηK) system is considered for the K* (885) and, a two-channel (πN, $K\Sigma$) system is treated for the N* (1238). The input forces in the first two cases are taken to be due to the exchange of the known vector mesons and in the last case the baryons alone. The masses and coupling constants of the exchanged particles are taken from experiment; the coupling constants which cannot be related in a direct manner to experimental quantities are related to the others by the assumption of SU_3 symmetry. Straight cutoffs are used to insure that the multichannel ND^{-1} equations have a unique solution. Full numerical solutions of these equations are obtained by the matrix inversion technique. The values of the cutoffs were adjusted in the three examples to yield a peak in the cross section at the observed energy for the one-channel case and readjusted (to a lower value) to reproduce the resonant energy in the presence of the inelastic channels. This allows one to study the effect of the additional channels on the width and shape of the resonances. With the latter values of the cutoffs, the inelastic channels are turned off, and the changes in the positions of the resonances are noted in order to estimate the relative contributions of the forces producing the resonance. It is noted that the $\pi\omega$ channel has more effect on the position of the ρ than does the $K\bar{K}$ channel. Also, the $K\Sigma$ channel has relatively little effect on the N* (even though for pure SU_3 symmetry the N* is equally composed of πN and $K\Sigma$). All the calculated widths are two to five times larger than the observed values, indicating that the lowest mass channels coupled via the longest range forces do not constitute a realistic model. (auth)

16561 ELASTIC SCATTERING AND CROSS SECTIONS IN ANTIPROTON-PROTON INTERACTIONS AT 3.3 AND 3.7 Bev/c. T. Ferbel (Yale Univ., New Haven), A. Firestone, J. Sandweiss, H. D. Taft, M. Gailloud, T. W. Morris, A. H. Bachman, P. Baumel, and R. M. Lea. Phys. Rev., 137: B1250-5(Mar. 8, 1965).

The elastic, the pion-production, and the multipion-annihilation cross sections for antiproton-proton interactions at 3.28 and 3.66 Bev/c incident antiproton momenta were measured. A comparison of the elastic interactions at 3.28 Bev/c with a purely-absorbing disc optical model gave a best value for the radius of interaction of 1.3 F. The real part of the forward scattering amplitude was found to be less than 20% of the imaginary part. A study of the asymmetries in double elastic scatters yielded a value for a polarizing power of the hydrogen consistent with zero when averaged over production angles. (auth)

16562 UNITARY OR OCTAL SYMMETRY? G. Cocho (Universidad de Mexico, Mexico City). Phys. Rev., 137: B1255-8(Mar. 8, 1965).

Octal symmetry (R_8 = group of rotations in eight dimensions) is applied to the strong interactions. If the existence of an octet m and a singlet λ of spinless mesons is assumed, a bootstrap mechanism allows the existence of 36 vector mesons with the coupling constants given by the R_8 group. Under $R_8 \subset R_9$ the 36-plet of vector mesons splits in an octet v' [with $\eta(780)$, K(730), $\pi(560)$ as a possible identification] and a 28-plet v. From octal symmetry a multiplicative quantum number N (block parity) is obtained which forbids the decay $v' \rightarrow m + m$ and perhaps explains the small width of this octet. A reasonable mass formula allows us to predict the masses of the v,v' vector mesons and suitable candidates with the predicted masses are found. The partial widths for the $v \rightarrow m + m$ decays are consistent with the experimental data and, in particular, with $\Gamma_{K(1175)\rightarrow K\pi}$, $\Gamma_{\pi(1220)\rightarrow\pi\pi}$ being small. (auth)

16563 SOME CONSEQUENCES OF POSSIBLE QUADRATIC INTERMEDIATE-VECTOR-BOSON INTERACTIONS WITH HADRONS. S. V. Pepper, C. Ryan, S. Okubo, and R. E. Marshak (Univ. of Rochester, N. Y.). Phys. Rev., 137: B1259-66(Mar. 8, 1965). (UR-875-60)

Some consequences of a hypothesis that the intermediate-vector boson supposed to be responsible for the weak interactions may have quadratic strong interactions with the nucleon are investigated. No contradiction is found with the existing experimental data if the mass of the vector boson is greater than 2.5 Bev. In this scheme, it is possible to explain the small difference between renormalized vector coupling constants of β and meson(μ) decays. Some experiments are suggested to test the validity of the postulated strong quadratic interaction. (auth)

16564 SELF-CONSISTENT, NONDEGENERATE MULTIPLETS. L. F. Cook and J. E. Paton (Princeton Univ., N. J.). Phys. Rev., 137: B1267-80(Mar. 8, 1965).

The restrictions of self-consistency are investigated for two sets of interacting particles—vector and scalar (or pseudoscalar)—with unequal masses. Self-consistency is studied within a field-theoretic framework and within a bootstrap framework. It is assumed that solutions exist when the particles of a given set have equal masses and the coupling constants are proportional to the structure constants of SU_3. The unequal-mass case is studied by perturbing the equal-mass solutions and retaining only first-order terms in the mass and coupling-constant shifts. It is found that fully self-consistent solutions do not exist in either case, but it is seen how such solutions can come about in the field-theoretic case. In the bootstrap analysis it is very difficult to understand how self-consistent solutions develop unless hidden identities are satisfied. (auth)

16565 HIGH-ENERGY BEHAVIOR IN FIELD THEORY AND DILATATIONAL SYMMETRY. M. K. Banerjee (Saha Inst. of Nuclear Physics, Calcutta), M. Kugler, C. A. Levinson, and I. J. Muzinich. Phys. Rev., 137: B1280-90(Mar. 8, 1965). (TID-21355)

The high-energy forward-scattering amplitude in $\lambda\phi^4$ theory is investigated by means of the Bethe-Salpeter equation. The class of irreducible diagrams which have dilatational symmetry at high energies is considered as kernels for the Bethe-Salpeter equation. For these kernels, the equation is solved using a Mellin transform. The solution is found to contain a term which, at high energies, behaves like $E^{2\alpha}/(\ln E)^c$. This term is caused by a branch cut in a complex four-dimensional Euclidean angular-momentum plane. A lower bound for n_0 is obtained from a simple diagram. Using the upper bound on n_0 which results from unitarity, an upper bound on the coupling constant is obtained: $\lambda < (3\sqrt{8})\pi^2$. (auth)

16566 FORM OF THE INTERACTION IN LAMBDA-HYPERON BETA DECAY. Robert P. Ely (Univ. of California, Berkeley), George Gidal, George E. Kalmus, Wilson M. Powell, William J. Singleton, Cyril Henderson, David J. Miller, and F. Russel Stannard. Phys. Rev., 137: B1302-6(Mar. 8, 1965). (UCRL-11672)

The form of the $\Lambda\beta$-decay interaction was studied by using lambdas produced by stopping mesons (K^-) in the Berkeley 30-in. propane-freon bubble chamber. A selected sample of 59 Λ_β decays were analyzed in the Λ rest system, and 50 of these were further studied in the laboratory system. The results show that a pure tensor interaction can be ruled out with 98% confidence, and for mixtures of vector and axial vector, $|C_A/C_V|$ is greater than 0.7 with 95% confidence. Scalar and pseudoscalar, either alone or with small admixtures of tensor, cannot be ruled out. Pure axial-vector and V ± A are consistent with the data. (auth)

16567 INVERSE COMPTON SCATTERING OF COSMIC-RAY ELECTRONS. Frank C. Jones (Goddard Space Flight Center. Greenbelt, Md.). Phys. Rev., 137: B1306-11 (Mar. 8, 1965).

It has long been known that an important mode of energy loss for cosmic electrons is inverse Compton scattering with photons of starlight. Previous calculations of $\langle d\mathscr{E}/dt\rangle_{av}$ due to this process have involved nonsystematic approximations involving the form of the Klein-Nishina formula and the angular distribution of the radiation as seen in the electron's rest frame. An electron of arbitrary energy in an isotropic thermal radiation field of temperature T is considered. A formally correct expression for $\langle d\mathscr{E}/dt\rangle_{av}$ is obtained as an asymptotic expansion in the quantity $\mathscr{E}kT/(m_ec^2)^2$ considered as a small parameter. The often quoted result $\langle d\mathscr{E}/dt\rangle_{av} \propto \mathscr{E}^2$ is seen to be the zero-order term in this expansion. It is also seen that the energy-loss rate changes sign at an energy $\mathscr{E} \approx \frac{3}{2}$ kT as would be expected from thermodynamics. A derivation of the zero-order term is given from classical radiation theory, and from this it is seen that this term also describes the energy-loss rate due to synchrotron radiation as well as from inverse Compton scattering. (auth)

16568 SIMPLE DERIVATION OF BROKEN-SU_3 PREDICTIONS. Kiyomi Itabashi (Argonne National Lab., Ill.). Phys. Rev., 137: B1312-17(Mar. 8, 1965).

A new method is proposed for deriving a complete set of relations among various transition amplitudes under the broken SU_3 symmetry. This method is applicable to any kind of reactions conserving both isospin and hypercharge and makes numerical manipulation much simpler than the conventional method. Also presented is its application to decay of the vector-meson octet and to meson-meson scattering. (auth)

16569 GENERAL S-MATRIX METHODS FOR CALCULATION OF PERTURBATIONS ON THE STRONG INTERACTIONS. Roger F. Dashen and Steven C. Frautschi (California Inst. of Tech., Pasadena). Phys. Rev., 137: B1318-30(Mar. 8, 1965).

Recently, an on-the-mass-shell, S-matrix method was proposed for computing the effects of small perturbations on the masses and coupling constants of strongly interacting particles. The method is generalized to the multichannel case. The use of group-theoretical techniques in reducing the complexity of the method is described in detail. (auth)

16570 OCTET ENHANCEMENT IN THE B AND Δ SUPERMULTIPLETS. Roger F. Dashen and Steven C. Frautschi (California Inst. of Tech., Pasadena). Phys. Rev., 137: B1331-49(Mar. 8, 1965).

The bootstrap theory of octet enhancement is described and is applied in particular to strong and electromagnetic mass splittings within the $J^P = \frac{1}{2}^+$ baryon octet and $J = \frac{3}{2}^+$ decuplet. The results are in good agreement with experiment. (auth)

16571 LOWER BOUNDS ON THE SHRINKING OF DIFFRACTION PEAKS. K. L. Kowalski (Case Inst. of Tech., Cleveland). Phys. Rev., 137: B1350-1(Mar. 8, 1965).

Lower bounds on the width of a diffraction peak are found using unitarity and analyticity in $\cos\theta$ in Lehmann-type ellipses. When the forward elastic-scattering amplitude is predominantly imaginary, the lower bound obtained is proportional to $(\ln s)^{-2}$. In deriving this result no restrictions, except those imposed by unitarity and analyticity, were made concerning the asymptotic behavior of the total cross section. (auth)

16572 GOLDSTEIN'S BETHE-SALPETER EQUATION AND THE ASYMPTOTIC BEHAVIOR OF A RELATED SCATTERING AMPLITUDE. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B1352-7(Mar. 8, 1965). (BNL-8531)

Exact solutions in closed form are found to the Bethe-Salpeter equation for the zero-energy scalar bound states of two spinor particles exchanging massless bosons in the ladder approximation. It is shown that the normal solution with a complex angular momentum l always exists for any $\lambda > 0$, uniquely if $m \neq 0$ but not uniquely if $m = 0$, where λ is the square of the coupling constant and m is the mass of the spinor particle. The exact solution to the integral equation for the trace of the corresponding scattering amplitude is obtained in closed form only when $m = 0$. Its high-energy behavior in the crossed channel (t channel) is shown to be of the form $(-t)^{\alpha}[\ln(-t)]^{-\frac{1}{2}}$, where $l = \alpha$ is a branch point of the above Bethe-Salpeter amplitude in the complex l plane. Some related problems are also discussed. (auth)

16573 EXPERIMENT FOR OBSERVING THE VACUUM SCATTERING OF LIGHT BY LIGHT. Gerald Rosen and F. C. Whitmore (Southwest Research Inst., San Antonio). Phys. Rev., 137: B1357-9(Mar. 8, 1965).

An "x-ray flashbulb" experiment for observing photon-photon scattering in vacuum is proposed and is briefly analyzed. Rather conservative estimates show that about ten to twenty scattering events can be initiated by two x-ray flashbulbs, properly oriented and synchronized to flash together in an appropriate experimental arrangement. (auth)

16574 DETECTION OF THE ELECTROMAGNETIC RADIATION FROM NUCLEAR EXPLOSIONS IN SPACE. W. J. Karzas and Richard Latter (RAND Corp., Santa Monica, Calif.). Phys. Rev., 137: B1369-78(Mar. 8, 1965).

The electromagnetic signal generated by interaction of nuclear-explosion-induced electric currents with the geo-

magnetic field can serve as a basis for detecting nuclear explosions which take place at extreme distances from the earth. An earlier theory of this phenomenon is extended to allow estimates of the maximum detection range. It is concluded that this electromagnetic signal may be detected at distances of the order of $10^7 Y_{kt}^{1/3}$ km from a nuclear explosion of total yield Y_{kt} kilotons. (auth)

16575 FLUCTUATIONS WITH TIME OF SCATTERED-PARTICLE INTENSITIES. M. L. Goldberger (Princeton Univ., N. J.) and K. M. Watson. Phys. Rev., 137: B1396-1409(Mar. 8, 1965).

The fluctuations in counting rate of a particle detector are studied. These may be used to study the coherence properties of the beam. For the case of electromagnetic radiation they may be used to study spectral line shapes. The fluctuations in intensity of scattered particles provide a means of studying fluctuation phenomena in the target. (auth)

16576 LOW-ENERGY EQUIVALENT-POTENTIAL APPROACH FOR STRONG INTERACTIONS. Louis A. P. Balazs (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 137: B1510-13(Mar. 22, 1965).

Equations are given for constructing an equivalent potential at each energy from the crossed-channel absorptive part. These are straightforward generalizations of the Charap-Fubini formulas. The absorptive part can be calculated with the help of the strip approximation. If the equations are solved by iteration, the potential can be obtained more and more accurately at smaller distances. The first approximation consists of an appropriate number of crossed-channel partial waves which can be calculated by solving a Schrödinger equation with an equivalent potential as input. The approach is applied in lowest order to calculate the parameters of the ρ and φ mesons. (auth)

16577 LORENTZ INVARIANCE AND THE INTERPRETATION OF SU(6) THEORY. M. A. B. Beg and A. Pais (Rockefeller Inst., New York). Phys. Rev., 137: B1514-22 (Mar. 22, 1965).

Conclusions drawn so far from the SU(6) theory are reviewed. A further discussion of the magnetic moments of long-lived baryons appears to render implausible the existence of an integrally charged sextet [SU(3) triplet with spin ½]. The question of Lorentz invariance is discussed in some detail. A relativistic completion procedure is developed by means of which one can implement the requirements both of Lorentz invariance and of SU(6) invariance for effective S-matrix elements. This procedure applies equally well to an interaction Lagrangian but not to the full Lagrangian including the free-field terms. The group SU(6) apparently has to be interpreted as a dynamical group which applies to one-particle states at zero momentum. Lorentz invariance provides a natural mechanism for the first-stage breakdown of SU(6). Considering SU(6) invariance as a strictly zero-momentum property, unique predictions to order v/c in virtue of Lorentz invariance are obtained. (auth)

16578 STRONG-INTERACTION SYMMETRIES BASED UPON RANK-THREE LIE GROUPS. I. S. Gerstein and M. L. Whippman (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 137: B1522-9(Mar. 22, 1965).

All rank-three simple Lie groups are considered as possible candidates for a higher symmetry of strong interactions. All such groups imply the existence of a new quantum number X, the oddness, and of odd particles with nonzero values of X. Because of uncertainties in the experimental observation of these particles, an attempt is made to obtain evidence of such symmetries in the properties of ordinary (X = 0) particles. Arguments are given to show that ϕ decay into ρ and π mesons is a particularly good place to look for such evidence. In all groups, the vector mesons are assigned to the regular representation, and mass formulas and decay rates are derived for various assignments of the pseudoscalar mesons and the mass operator to representations of the group. It is found that it is possible to formulate a general criterion, which can be applied to all rank-three Lie groups, for assigning these representations, and that with this assignment all such groups give the same mass formula and decay widths for the vector mesons, namely, $(3\omega + \rho - 4K^*)(3\phi + \rho - 4K^*) + 8(\rho - K^*)^2 = 0$ and $\Gamma(\phi \to \rho\pi) = 0.3 - 0.6$ Mev, $\Gamma(\phi \to K\bar{K}) = 2$ Mev, in extremely good agreement with experiment. The main properties of rank-three Lie groups are summarized. (auth)

16579 SINGLE-PARTICLE EXCHANGE MODELS FOR THE REACTIONS $\pi p \to \rho p$, $\bar{p}p \to \bar{Y}Y$, AND $np \to pn$. Loyal Durand, III, and Yam Tsi Chiu (Yale Univ., New Haven). Phys. Rev., 137: B1530-4(Mar. 22, 1965).

The predictions of single-particle exchange models for particle reactions at high energies were shown by several authors to be altered significantly by the effects of the strong absorption from the entrance and exit channels into the generally numerous competing channels. The necessary modifications of the usual single-particle exchange models were discussed by Sopkovich, Durand, and Chiu, and by Gottfried and Jackson. The predictions of the modified models for the reactions $\pi^\pm p(\pi^0,\omega)\rho^\pm p$, $\bar{p}p(K,K^*)\bar{Y}Y$, and $np(\pi,\rho)pn$ are compared with the results of recent experiments. [ab(e,f, . . .)cd denotes the reaction a + b → c + d, assumed to proceed through the exchange of particles e,f, ...] The effects of the particle spins, including the decay angular distribution of the $\rho^\pm$ in the first reaction and the two-particle spin correlations in the $\bar{Y}Y$ system in the second, are discussed in detail. The rather striking success of the modified theories for the foregoing reactions suggests strongly that ideas underlying the modifications are correct in principle, if not in detail. (auth)

16580 COVARIANT POLARIZATION MATRICES FOR MASSIVE AND MASSLESS PARTICLES OF ARBITRARY SPIN. Daniel Zwanziger (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., 137: B1535-45(Mar. 22, 1965).

A quantity which transforms according to a (finite-dimensional) representation of the homogeneous Lorentz group is called covariant. The now familiar transformation in the spin space of amplitudes, which produces covariant analytic amplitudes, is applied to polarization matrices to obtain covariant polarization matrices. The cross section for an arbitrary scattering process involving polarized particles and polarization analyzers is expressed directly in terms of covariants. Whereas the usual formalism represents the polarization of a massive particle in its rest frame, where the polarization matrices form a basis for a reducible representation of the rotation group with an expansion in irreducible multipoles of order 0 to 2s, the covariant polarization matrices form a basis for an irreducible representation of the Lorentz group, denoted by $(\frac{1}{2},\frac{1}{2})$ for spin s. The polarization of a particle of spin s is represented by a real Lorentz tensor of rank 2s that is completely symmetric and traceless in any pair of indices. The positivity condition and multipole expansion are given in this representation. The case of spin 1 is studied in detail. Covariant polarization matrices are obtained for massless particles and are expressed in terms of a pseudoscalar representing the degree of longitudinal (circular) polarization, a scalar representing the degree of transverse (linear) polarization, and a 4-vector representing the direction of the transverse polarization. The case of photons is studied in detail, and it is seen that the longitudinal and transverse polarization of light correspond, respectively, to the dipole and quadrupole polarization of massive spin-1 particles. (auth)

16581 MASS SPLITTING IN A BOOTSTRAP MODEL OF FOUR MULTIPLETS. Richard H. Capps (Imperial Coll., of Science and Tech., London). Phys. Rev., 137: B1545-52 (Mar. 22, 1965).

A bootstrap model of the pseudoscalar meson octet (P), vector meson octet (V), baryon octet (B), and baryon $J^P = \frac{3}{2}^+$ decuplet (B*) is considered. A simple dynamical equation, used previously to predict the mass-splitting of the P and V multiplets, is applied to the B and B* multiplets. The approximations used are crude, but the calculated results agree closely with the experimental baryon masses. The main reasons for this agreement are expressed simply

in terms of various Clebsch-Gordan coefficients of SU_3. The terms in the equation that are not linear in the mass splitting lead to an appreciable violation of the Gell-Mann-Okubo formula for the V mesons, and to negligible violations of the corresponding formulas for the B and B* multiplets. Matrix ND^{-1} dispersion relations are used to clarify the basic physical assumptions involved in the dynamical equation. (auth)

16582 MESON-BARYON COUPLINGS IN THE STATIC MODEL. Yasuo Hara (Univ. of Chicago). Phys. Rev., 137: B1553-5(Mar. 22, 1965). (COO-264-223; EFINS-64-58)

The static model with one-pion approximation is applied to inelastic processes. The D to F ratio of the octet baryon (B_8)-B_8-octet axial-vector meson coupling and the D to F ratio of the E_8-B_8-octet vector meson M1 coupling are found to be equal to that of the B_8-B_8-octet pseudoscalar meson coupling which is about 2. The D to F ratio of the B_8-B_8-octet scalar meson coupling is found to be about −0.6. The mass splittings of decuplet and 35-plet baryons are calculated assuming the tadpole model. (auth)

16583 DYNAMICAL MODEL FOR NONLEPTONIC DECAYS OF HYPERONS. Riazuddin (Univ. of Rochester, N. Y.), Fayyazuddin, and A. H. Zimmerman. Phys. Rev., 137: B1556-61(Mar. 22, 1965). (UR-875-59)

A dynamical model based on broken unitary symmetry is developed for nonleptonic decays of hyperons. The contributions to these decays are taken from the primary current-current interaction and from poles due to the baryons, the K meson, Y_0^* (1405), and the decuplet of baryon resonances (B_{10}^*). The contributions from the baryon and K-meson poles are calculated on the assumption that weak baryon-baryon and K-π transitions transform like divergences of the relevant weak currents, which are members of octets. The contributions from poles due to Y_0^* and the B_{10}^* resonances must be included to explain the p-wave amplitudes. Both s- and p-wave amplitudes then satisfy the triangular relations and fit the experimental values for the signs and magnitudes. The model predicts the correct sign of the K_1^0-K_1^+ mass difference. (auth)

16584 FORBIDDEN TRANSITIONS IN POLE MODELS WITH UNITARY SYMMETRY. Harry J. Lipkin (Argonne National Lab., Ill.). Phys. Rev., 137: B1561-5(Mar. 22, 1965).

Two selection rules are derived which explain vanishing transition matrix elements found for many processes. A decay is forbidden in a pole model having a momentum-independent symmetry-breaking vertex and a symmetry-conserving vertex with arbitrary form factors if either all propagators are equal in magnitude and the matrix elements of the symmetry-breaking vertex are proportional to those of a generator of the symmetry group, or the propagators involve only known mass differences described by the Gell-Mann-Okubo mass formula and the matrix elements of the symmetry-breaking vertex are described by the D coupling of three unitary octets. Applications to K decays and nonleptonic Σ decays are discussed. (auth)

16585 $\pi^+\pi^+$p RESONANCE — A STATIC-MODEL CALCULATION. T. L. Trueman (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B1566-72(Mar. 22, 1965). (BNL-8546)

The $\pi^+\pi^+$p scattering amplitude in the $J = 5/2$ (even-parity) state is calculated, in the static-nucleon approximation. The isobar model is not used, and the symmetry required by Bose statistics is maintained throughout. As a consequence, although the static model radically simplifies the three-body problem, the solution displays some interesting three-body features. A discussion of the physical interpretation of the solution is presented, especially with regard to the definition of a three-particle resonance. Such a resonance is found; rough values for the position and half-width are 1550 and 125 Mev, respectively. No arbitrary parameters are used in obtaining these numbers, which agree rather well with recently reported experimental values for a $\pi^+\pi^+$p enhancement in the final state of $\pi^+ + p \rightarrow \pi^- + \pi^+ + \pi^+ + p$. (auth)

16586 SOLUTIONS TO THE N AND D EQUATIONS AS EXPLICIT FUNCTIONS OF THE COUPLING CONSTANT. James S. Ball (Univ. of California, Los Angeles). Phys. Rev., 137: B1573-6(Mar. 22, 1965).

A method for obtaining solutions to the N and D equations as explicit functions of the coupling constant is developed. The analytic properties of N and D in the coupling-constant plane are investigated. Finally this method, which is particularly useful in bootstrap calculations, is used to find the self-consistent parameters in several types of scalar and pseudoscalar meson bootstrap calculations. (auth)

16587 ANALYTIC CONTINUATION OF PARTIAL-WAVE AMPLITUDE IN THE COMPLEX ANGULAR-MOMENTUM PLANE. Haridas Banerjee and G. C. Joshi (Univ. of Delhi). Phys. Rev., 137: B1576-86(Mar. 22, 1965).

An attempt is made to continue analytically the partial-wave amplitude for the scattering of two identical spinless particles in the complex l plane, exploiting unitarity and analyticity properties in s. The Froissart-Gribov representation for the partial-wave amplitude is known to be holomorphic in the region $\mathrm{Re}\,l > \alpha$ of the complex l plane provided the absorptive part $A_t(s,t)$ of $A(s,t)$, the scattering amplitude in the t channel, is bounded by t^α for any fixed s. Apart from the above assumptions, two crucial hypotheses on which the present analysis is based are the possibility of extending unitarity in the inelastic region to complex values of l, and the boundedness condition, viz., that both $A_t(s,t)$ and $A(s,t)$ are asymptotically bounded by the maximum of $(t^\beta/s^\gamma, s^\beta/t^\gamma)$ if s and t are both sufficiently large with $\gamma > 0$ and $\beta < \min(1,\gamma)$. With the help of the N/D technique it is then possible to continue analytically the partial-wave amplitude up to the line $\mathrm{Re}\,l = \beta$ and show that it is meromorphic in the region $\beta < \mathrm{Re}\,l \leq \alpha$. The domain of meromorphy of the partial-wave amplitude obtained by the method of analytic completion is smaller than the preceding one. The analytically continued partial-wave amplitude is bounded by $|l|^{-\frac{1}{2}}$ for large values of $|l|$, so that a Regge representation for $A(s,t)$ can be obtained. The N/D method of analytic continuation does not work beyond the line $\mathrm{Re}\,l = -1$ even if one assumes $\beta < -1$. It was also shown that accumulation of poles at $l = -\frac{1}{2}$ near threshold, a feature which was pointed out by several authors, is also manifested in the analytically continued partial-wave amplitude. (auth)

16588 COVARIANT DESCRIPTION OF SEVERAL SPINLESS PARTICLES. Francis R. Halpern (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: B1587-91 (Mar. 22, 1965).

To describe a state of n particles it is necessary to construct a matrix element or wave function from the momentum vectors of the n particles. It is usually possible to write down a simple function having the correct angular momentum and parity. It is not clear in what sense the choice made is general. This is in contrast to the two-particle states, where the spherical harmonics form a complete orthonormal set over the phase space. The spherical harmonics are homogeneous polynomials in the components of the relative momentum of the two particles. It will be shown that homogeneous polynomials in the n-1 relative momenta of n particles entering an n-particle state, with a correction term for relativistic kinematics, form a complete orthonormal set of functions over the n-body phase space and provide a basis for a systematic classification of n-body states. There are some new quantum numbers (degeneracy indices) that enter and may or may not have physical significance. The application of these notions to ω decay is briefly considered. The basis of this classification is the determination of a larger invariance group than the rotations for a system of free particles. The Lie algebra of generators of this group furnishes a complete commuting set of operators, and it is exhibited. The eigenfunctions of this set are given. (auth)

16589 DETERMINATION OF SUBTRACTION TERMS IN S-MATRIX THEORY. C. Edward Jones (Princeton Univ., N. J.). Phys. Rev., 137: B1592-7(Mar. 22, 1965).

A detailed discussion of several points connected with the determination of subtraction constants in S-matrix

theory is made. By considering examples of asymptotic behavior of scattering amplitudes characteristic of poles and cuts in the angular-momentum plane, explicit formulas for the subtraction functions in terms of the absorptive part are derived. It is emphasized that it is not necessary for all singularities to retreat to the left half angular-momentum plane in order for the subtraction functions to be completely determined. An explicit demonstration, for one example, is given of the fact that for nonpolynomial asymptotic behavior of scattering amplitudes in momentum transfer, the partial-wave amplitudes for all physical angular momenta are generally expected to be linked by analytic continuation in the complex angular-momentum plane. This property of partial-wave amplitudes is sometimes stated as an S-matrix postulate and referred to as maximal analyticity of the second degree. (auth)

16590 BOUNDS FOR A CLASS OF BETHE-SALPETER AMPLITUDES. George Tiktopoulos and S. B. Treiman (Princeton Univ., N. J.). Phys. Rev., 137: B1597-1602 (Mar. 22, 1965).

For a certain wide class of kernels involving trilinear coupling of scalar particles, the absorptive part of the Bethe-Salpeter amplitude for forward scattering is bounded from above and below. The bounds are expressed in the form $B_1 s^{\alpha_1} \leq A(s) \leq B_2 S^{\alpha_2}$, where s is the squared c.m. energy and B_1 and B_2 are positive constants. Expressions for the exponents α_1 and α_2 are given as functions of the coupling constant g. For the straight ladder model, α_1 and α_2 coincide for all values of g, the common expression agreeing with an exact result of Nakanishi. For the more complicated models, α_1 and α_2 do not in general coincide. However, in the strong-coupling limit $g \to \infty$, it is found that $\alpha_2/\alpha_1 \to 1$; moreover, the common asymptotic behavior $\alpha_{1,2} \underset{g\to\infty}{\to} g/4\pi m$ is the same for all the models, including the straight-ladder model. (auth)

16591 CORRECTIONS TO THE OCTUPLET SPURION IN THE NONLEPTONIC DECAYS OF THE HYPERONS. Mahiko Suzuki (Tokyo Univ.). Phys. Rev., 137: B1602-4 (Mar. 22, 1965).

Corrections due to the 27-plet spurion and the second-order electromagnetic effects are calculated to the octuplet spurion in the nonleptonic hyperon decays. The 27-plet spurion predicts a relation among small deviations from the $\Delta I = 1/2$ rule, namely $(\langle\Lambda|p\pi^-\rangle + \sqrt{2}\langle\Lambda|n\pi^0\rangle) = -(\langle\Xi^-|\Lambda\pi^-\rangle + \sqrt{2}\langle\Xi^0|\Lambda\pi^0\rangle)$ for the parity-violating amplitudes. This holds as it stands if the second-order electromagnetic effects are introduced on the assumption of the octuplet tadpole mechanism. A test of this relation, although still not possible with present experimental data, has a deep significance for the structure of the weak interactions. (auth)

16592 STUDY OF K_{e4} DECAYS. Claude Kacser (Univ. of Maryland, College Park), Paul Singer, and Tran N. Truong. Phys. Rev., 137: B1605-20(Mar. 22, 1965). (TID-21352)

It is assumed that the $K \to \pi + \pi + e + \nu$ process has a Born term dominated by K^* exchange. By assuming a nearly conserved axial current a Goldberger-Treiman-type relation is obtained by which the K_{e4} amplitude is related to the K^* width and $K \to \mu + \nu$ amplitude. This is used to determine the left-hand cut for a set of partial-wave dispersion relations. With the assumption of elastic unitarity for pion-pion scattering, integral equations of the Muskhelishvili-Omnès type are obtained, which are then solved using various assumed forms for the pion-pion T = 0 interaction. The effect of the ρ resonance is included in the T = 1 P-wave amplitude. Agreement is obtained with the experimental rate for K_{e4}^+ decay when the S-wave pion-pion interaction is described by a scattering-length approximation with a scattering length of $\alpha_0 = (1 \pm 0.3)$ pion Compton wavelengths. With this value of α_0, the two-pion invariant mass distribution is in good agreement with experiment, and the total P-wave contribution to the total rate is predicted to be 18%. If a σ meson (T = 0, S-wave resonance at 400 Mev) is assumed to dominate the S-wave pion-pion interaction, the calculated rate becomes larger than the experimental one by two orders of magnitude. The possibility of T violation is discussed. (auth)

16593 HYPERCHARGE CONSERVATION, CP INVARIANCE AND THE POSSIBLE EXISTENCE OF A ZERO-MASS ZERO-SPIN FIELD. T. D. Lee (Columbia Univ., New York). Phys. Rev., 137: B1621-7(Mar. 22, 1965). (TID-21340)

It is shown that by introducing a neutral zero-mass zero-spin field ϕ, the Lagrangian density of all interactions (including weak interactions) can be made invariant under the hypercharge gauge transformation. Consequently, there exists a hypercharge current density J_μ that is absolutely conserved. The current density J_μ is related to the usual hypercharge current density j_μ of all the presently known particles by $J_\mu = j_\mu - \lambda^{-1}(\partial\phi/\partial x_\mu)$, where λ is a coupling parameter. The same Lagrangian density is invariant under CP transformation, time-reversal transformation, and Lorentz transformation. It turns out that if the conserved quantity $\int J_4 d^3r \neq 0$, then there exists an energy difference between any hypercharged particle and its antiparticle with the same momentum. Such an energy difference would induce decays such as $K_2^0 \to 2\pi$, and the decay rate is proportional to the square of the K-meson energy. (auth)

16594 HYPERON PRODUCTION BY NEUTRINOS IN AN SU_3 MODEL. N. Cabibbo (Univ. of California, Berkeley) and Frank Chilton. Phys. Rev., 137: B1628-34(Mar. 22, 1965).

An SU_3 model of weak interactions is used to discuss amplitudes and cross sections for hyperon production by neutrinos. Numerical results for the cross sections are given. The notion of first- and second-class currents is extended to currents transforming like multiplets under SU_3. (auth)

16595 NEW APPROACH TO THE DETECTION OF SOLAR NEUTRINOS VIA INVERSE BETA DECAY. F. Reines and R. M. Woods, Jr. (Case Inst. of Tech., Cleveland). Phys. Rev. Letters, 14: 20-4(Jan. 4, 1965).

A direct-counting experiment is discussed in which solar neutrinos are detected using the reactions $^{11}B + \nu_e \to {}^{11}C + e^-$ and $^7Li + \nu_e \to {}^7Be + e^-$. The theoretical bases are outlined, and the background radiations are discussed. (D.C.W.)

16596 PRODUCTION AND DECAY OF $\Xi^*(1820)$. Gerald A. Smith, James S. Lindsey, Janice Button-Shafer, and Joseph J. Murray (Univ. of California, Berkeley). Phys. Rev. Letters., 14: 25-8(Jan. 4, 1965). (UCRL-11778)

The results of an investigation of final states in meson (K^-)-proton interactions at 2.45 to 2.70 Bev/c are presented, including production cross sections and decay rates of $\Xi^*(1820)$ as well as results on the spin and parity of this state. (D.C.W.)

16597 LOW-ENERGY K^--p INTERACTION AND INTERPRETATION OF THE 1405-Mev Y_0^* RESONANCE AS A $\bar{K}N$ BOUND STATE. Jae Kwan Kim (Columbia Univ., New York). Phys. Rev. Letters, 14: 29-30(Jan. 4, 1965).

The meson(K^-)-proton interactions were studied at momenta below 300 Mev/c. Cross sections and angular distributions were obtained, and the results were fitted to the Dalitz-Tuan theory, which assumes that the effective range is zero in the K^--p system. Two solutions were found, one of which was eliminated definitely. It was concluded that the $Y^*(1405$ Mev) is an s-wave K^--p bound state, which establishes the spin and parity of this state as $1/2^-$. (D.C.W.)

16598 SU(6) IN A BARYON BOOTSTRAP MODEL. Richard H. Capps (Imperial Coll. of Science and Tech., London). Phys. Rev. Letters, 14: 31-3(Jan. 4, 1965).

A baryon bootstrap model is constructed on the basis of SU(6) symmetry. (D.C.W.)

16599 BARYON SUPERMULTIPLET. J. G. Belinfante and R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Letters, 14: 33-5(Jan. 4, 1965). (CAR-882-7)

An SU(6) model is outlined in which a simple dynamical theory of the electromagnetic structure of the baryons is incorporated and in which the interactions of pseudoscalar mesons with the baryon octet and decuplet are taken to be the dominant interactions governing the structure of the low-lying baryon states. (D.C.W.)

16600 MODEL OF WEAK INTERACTIONS WITH CP VIOLATION. S. L. Glashow (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 35-8(Jan. 4, 1965).

A model of weak interactions is proposed, which allows for CP violation. A single current-current coupling is introduced where vector and axial-vector currents transform differently under SU(3), yet each transforms like a member of a unitary octet. (D.C.W.)

16601 INTRINSICALLY BROKEN U(6) ⊗ U(6) SYMMETRY FOR STRONG INTERACTIONS. PART II. K. Bardakci, J. M. Cornwall, P. G. O. Freund, and B. W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 14: 48-51(Jan. 11, 1965).

It is shown that the approximate symmetry group W(6) = U(6) ⊗ U(6) arises naturally when the six-dimensional linear group GL(6) is enlarged to a 144-parameter, noncompact group denoted by M(12). It is then shown that W(6) is the maximal compact subgroup of M(12). (D.C.W.)

16602 SU(6) AND SEMILEPTONIC INTERACTIONS. M. A. B. Beg and A. Pais (Rockefeller Inst., New York). Phys. Rev. Letters, 14: 51-4(Jan. 11, 1965).

The consequences are studied of the assumption that the effective strongly interacting particle currents of both the vector (V) and axial vector (A) types associated with the semi-leptonic processes transform according to the adjoint representation of the group SU(6). The implications of more restrictive dynamical assumptions which relate the adjoint representations for the V and A currents are also discussed. (D.C.W.)

16603 SMALL-ANGLE ELASTIC SCATTERING OF HIGH-ENERGY PROTONS FROM HYDROGEN. K. J. Foley, R. S. Gilmore, R. S. Jones, S. J. Lindenbaum, W. A. Love, S. Ozaki, E. H. Willen, R. Yamada, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 74-6(Jan. 18, 1965). (BNL-8717)

The differential cross section for elastic p-p scattering at four momenta from 7.92 to 17.82 Bev/c was measured at laboratory angles of 2 to 20 mrad. Least-squares fits to the data were obtained. Coulomb interference effects, particularly, were studied. (D.C.W.)

16604 ANGULAR MOMENTUM AND THE ALGEBRA OF CURRENT COMPONENTS. Murray Gell-Mann (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 14: 77-8(Jan. 18, 1965).

The relation of the algebra of U(6) to the angular momentum $\vec{J}$ is studied, as well as the manner in which the symmetry U(6) is broken down to U(3). (D.C.W.)

16605 ELECTROMAGNETIC MASS SPLITTING IN THE SU(6) SYMMETRY SCHEME. T. K. Kuo and Tsu Yao (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 79-81(Jan. 18, 1965). (BNL-8687)

The electromagnetic mass splittings of the baryon and meson multiplets are studied, assuming that the electromagnetic mass splitting is of second order in the electromagnetic interaction and that the electromagnetic current is a tensor in the 35 representation. (D.C.W.)

16606 OPTICAL THEOREM AS APPLIED TO CHARGED-PARTICLE SCATTERING TO YIELD TOTAL REACTION CROSS SECTIONS FROM ELASTIC-SCATTERING DATA. J. T. Holdeman and R. M. Thaler (Case Inst. of Tech., Cleveland). Phys. Rev. Letters, 14: 81-2(Jan. 18, 1965).

The procedure for obtaining total reaction cross sections for charged-particle scattering from elastic scattering data using the optical theorem is outlined. (D.C.W.)

16607 SU(6) AND THE ELECTROMAGNETIC FORM FACTORS. K. J. Barnes, P. Carruthers, and Frank von Hippel (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 14: 82-4(Jan. 18, 1965).

A nonstatic problem is discussed in which the possibility of an SU(6) symmetry arises naturally. It is shown that under a specific SU(6) invariance the neutron-proton magnetic moment ratio derived by Beg, Lee, and Pais generalizes to the form factor ratio $G_M^n(q^2)/G_M^p(q^2) = \mu_n/\mu_p = -\frac{2}{3}$, where q^2 is the square of the four-momentum transfer. The fact that the neutron has zero charge generalizes under this SU(6) to $G_E^n(q^2)/G_E^p(q^2) = 0$. (D.C.W.)

16608 SUM RULES FOR THE REAL PART OF THE FORWARD-SCATTERING AMPLITUDE. N. N. Khuri and T. Kinoshita (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 14: 84-6(Jan. 18, 1965).

Sum rules satisfied by the real part of a crossing-symmetric forward scattering amplitude are presented. (D.C.W.)

16609 NONLEPTONIC BARYON DECAYS IN SU(6). Ken Kawarabayashi (International Atomic Energy Agency, Trieste, Italy). Phys. Rev. Letters, 14: 86-9(Jan. 18, 1965).

Some consequences of the assumptions that strong interactions are approximately SU(6) invariant, that nonleptonic weak interactions transform like a member of an adjoint representation under SU(6), and that weak interactions are invariant under the operation of CP are considered. Sum rules for parity-conserving and parity-violating amplitudes are obtained. (D.C.W.)

16610 CP INVARIANCE IN WEAK INTERACTIONS AND THE PION DECAY ASYMMETRY. G. B. Cvijanovich, E. A. Jeannet, and E. C. G. Sudarshan (Univ. of Bern). Phys. Rev. Letters, 14: 117-18(Jan. 25, 1965).

It is proposed that a new particle, called the spion (spinning pion), is involved in the two-pion mode of K_2^0 and the three-pion mode of K^+. CP nonconservation is no longer implied by the observation of Christenson, and the observed π-μ decay correlations can be explained. Experimental tests of the decay mechanism are suggested. (D.C.W.)

16611 DETERMINATION OF THE $\Delta\delta^{2+}$-$\Delta\delta^{0}$ MASS DIFFERENCE. Martin G. Olsson (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 14: 118-21(Jan. 25, 1965). (COO-881-42)

The $\Delta\delta^{2+}$-$\Delta\delta^{0}$ mass difference was determined to be -0.45 ± 0.85 Mev by an analysis of data on $\Delta\delta$ formation, in π-p scattering. This value is compared with an SU(6) prediction and with various dynamical theories of SU(3) splitting. (D.C.W.)

16612 POSSIBLE NEW BARYON STATES OF SU(6) SYMMETRY. I. P. Gyuk and S. F. Tuan (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 14: 121-6(Jan. 25, 1965).

A set of solutions to the mass formulas of Beg and Singh for the 70-representation of SU(6) is proposed, based partly upon the postulated existence of an η octet of baryon states. (D.C.W.)

16613 PERIPHERAL PRODUCTION OF ρ^0 MESONS BY PIONS OF 12 AND 18 Bev/c. Lawrence W. Jones (Univ. of Michigan, Ann Arbor). Phys. Rev. Letters, 14: 186-9 (Feb. 8, 1965).

The cross sections for meson (ρ^0) production in meson (π^-)-nucleon interactions at 12 and 18 Bev/c were measured. The results agreed well with a one-pion-exchange calculation without correction for initial- or final-state absorption or a form-factor term. (D.C.W.)

16614 IMPLICATIONS OF SU(6) SYMMETRY FOR TOTAL CROSS SECTIONS. K. Johnson and S. B. Treiman (Princeton Univ., N. J.). Phys. Rev. Letters, 14: 189-91 (Feb. 8, 1965).

The forward elastic scattering of pseudoscalar mesons on baryons is considered. Relations between the scattering amplitudes are obtained via SU(6). Through the optical theorem, a corresponding set of relations is implied for the total cross sections. Numerical results are included. (D.C.W.)

16615 EXPERIMENTAL CHECK OF THE JOHNSON-TREIMAN RELATION ON THE K-N TOTAL CROSS SECTIONS. Robert Good and Nguyen-huu Xuong (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 14: 191-2(Feb. 8, 1965).

The available data on the total cross sections of K-N interactions below 4 Bev/c are shown to support strongly the Johnson-Treiman relation for the K-N total cross sections from 0.6 to 3 Bev/c. (D.C.W.)

16616 ABSOLUTE DECAY RATE OF K_2^0 INTO CHARGED THREE-BODY MODES. L. Auerbach, K. Lande, A. K. Mann, F. J. Sciulli, H. Uto, D. H. White, and K. K. Young (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 14: 192-6(Feb. 8, 1965).

The results are presented of a measurement of the absolute rate of decay of the meson (K_2^0) into the modes $\pi^\pm - e^\pm - \nu$, $\pi^\pm - \mu^\pm - \nu$, and $\pi^+ - \pi^- - \pi^0$. (D.C.W.)

16617 MEASUREMENT OF THE RECOIL PROTON POLARIZATION IN ELASTIC π^+p SCATTERING AT Tπ EQUALS 410 AND 492 Mev. P. Bareyre, C. Bricman, M. J. Longo, et al. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev. Letters, 14: 198-201(Feb. 8, 1965).

The angular distribution of the recoil proton polarization in elastic π^+-p scattering at 410 and 492 Mev was measured. (D.C.W.)

16618 PHASE-SHIFT ANALYSIS IN π^+ SCATTERING AT Tπ LAB EQUALS 410 AND 492 Mev. P. Bareyre, C. Bricman, J. Sequinot, and G. Villet (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev. Letters, 14: 201-5 (Feb. 8, 1965).

The results of phase shift analyses of π^+-p scattering at 410 and 492 Mev are presented and are compared with experimental data and theoretical predictions using partial-wave dispersion relations. SPD and SPDF analyses were made for both 410 and 492 Mev, and an SPDFG analysis was also made for 492 Mev. (D.C.W.)

16619 CP INVARIANCE AND THE SHADOW UNIVERSE. K. Nishijima and M. H. Saffouri (Univ. of Illinois, Urbana). Phys. Rev. Letters, 14: 205-7(Feb. 8, 1965).

An interpretation of the two-pion decay mode of the long-lived component of the meson (K^0) beam is proposed, based on the assumption of CP invariance. (D.C.W.)

16620 RADIATION FROM AN ELECTRIC DIPOLE IN A PLASMA COLUMN. S. R. Seshadri (Sylvania Electronic Systems, Waltham, Mass.). Proc. Inst. Elec. Engrs., (London), 112: 249-53(Feb. 1965).

The radiation characteristics of an axially oriented electric dipole in an isotropic plasma column are investigated. Surface waves are found to be excited for frequencies of less than $1/\sqrt{2}$ times the plasma frequency. The dependence of the power carried by the surface wave, as well as that carried by the space wave, on the frequency and the radius of the plasma column is examined. The surface waves are found to be excited with maximum efficiency at about half the plasma frequency. The radiation pattern in the far zone is evaluated and found to have, in general, a maximum in the broadside and a null in the end-fire directions. The normalized radiation resistance is found to vary as the square of the frequency for small column dimensions and high frequencies. (auth)

16621 POSSIBLE EXISTENCE OF S-WAVE VIRTUAL STATES IN MESON-BARYON SCATTERING AMPLITUDES. Fujio Takagi (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 32: 778-86(Nov. 1964).

The possible existence of S-wave virtual states in some meson-baryon scattering amplitudes is pointed out assuming the usual analyticity in the complex energy plane for scattering amplitudes. These S-wave virtual states may develop into bound states when the related interaction strengths vary in a suitable way. If these S-wave virtual states are assigned to some unitary multiplet, one naturally obtains a unitary octet provided that the spin-parity of Y_1^* (1405 Mev) is $1/2^-$. The Y_1^* may be assigned not to a unitary singlet but to an isosinglet of this unitary octet. Other seven members of this octet may be the above-mentioned S-wave virtual states. (auth)

16622 THREE-BODY LEPTONIC DECAYS OF K-MESONS AND HYPERONS. Takao Kaneko (Meijo Univ., Nagoya, Japan). Progr. Theoret. Phys. (Kyoto), 32: 787-803(Nov. 1964).

A method of treating weak interaction processes involving composite particles is formulated on the basis of the theory of bound states of quantum field theory. The method is applied to the analysis of the decay $K^+ \to \pi^0 + l^+ + \nu$. And it is shown that under a possible set of assumptions ξ-value of this decay must lie between -1 and $+1$ irrespective of the structure of π and K-meson. Then the method is applied to the leptonic decays of hyperons, and it is shown that if the $\bar{K}$-baryon model is used for hyperons there is a possibility of understanding the smallness of the decay rates compared to the ones expected from the universal coupling theory. (auth)

16623 THRESHOLD BEHAVIOUR OF PARTIAL-WAVE DISPERSION RELATION. Susumu Furuichi and Minoru Yonezawa (Rikkyo Univ., Tokyo and Australian National Univ., Canberra). Progr. Theoret. Phys. (Kyoto), 32: 804-9(Nov. 1964).

A detailed analysis is made of the threshold behavior of the partial-wave dispersion relation, taking N-N scattering with spinless π and N as an example. It is shown up to the fourth order of the effective π-N coupling constant g that the correct threshold behavior of the amplitude is obtained due to the cancellation between the contribution from the right-hand cut and the contribution from the left-hand cut, though each of these contributions does not show the correct threshold behavior. (auth)

16624 A MODEL OF WEAK INTERACTIONS. Pratul Bandyopadhyay (Indian Statistical Inst., Calcutta). Progr. Theoret. Phys. (Kyoto), 32: 810-18(Nov. 1964).

A theory of weak interaction is proposed on the basis of a revised Nagoya model where it is suggested that there are two kinds of B-matter, the one having strangeness B_1^+ and the other having no strangeness B^+ and these B-matters can form bound states with muonic leptons (i.e., ν_μ and μ^-) only. Using this model and the model of muon decay proposed previously it is shown that one can have a uniform picture of all weak interactions. Moreover, $|\Delta S| = 1$ rule and $\Delta S/\Delta Q = -1$ decays can be interpreted in the very general framework of weak processes. This also helps us to understand the stability ν_e, ν_μ, $e^\pm$, and p and the instability of all other particles satisfactorily. (auth)

16625 AN APPLICATION OF SU_3 GROUP TO THE THEORY OF WEAK INTERACTIONS. Hirotaka Kanasugi and Hiroshi Nakamura (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 32: 819-36(Nov. 1964).

A theory of strong and weak interactions is proposed. Strong interactions are assumed to be invariant under an SU_3 group G_s and Gell-Mann's scheme is adopted for baryons. Weak interactions are postulated to be invariant under an SU_3 group (or an U_3 group) G_w which is closely related to the group G_s. Invariance under the CR-conjugation is required for both strong and weak interactions. The vector and axial-vector part of baryon currents are then determined to be of F- and D-type, respectively. Consequently, the vector parts of baryon currents are conserved and the coupling between pseudoscalar octet bosons and baryons is of D-type, if Goldberger-Treiman relation holds. It is shown that a special case of the theory is partly equivalent to a Cabibbo's model. The general theory of gauge transformation is applied to this model using a pair of spurions of an SU_3 group and intermediary mesons. Accordingly, $\delta S/\delta Q = -1$ transitions do not exist. As a hopeful example, a nine-fold way of leptons is proposed where weak interactions are quite symmetrical in baryonic and leptonic multiplicities. This model requires the existence of four new leptons (two charged and two neutral) with non-zero mass and several intermediary mesons. The charged new leptons decay rapidly and, consequently, the detection of these new leptons is difficult at present time. The $\delta S = 0$ and $\delta S/\delta Q =$

l interactions are of scalar coupling and of vector coupling for the group G_w, respectively. It is shown that $\delta S/\delta Q = -1$ transitions can also be present in this model as an interaction of vector coupling for the group G_w. (auth)

16626 THE FORM FACTORS IN THE K_{l4} DECAY. Azuma Toda (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 32: 855-6(Nov. 1964).

An attempt is made to evaluate the form factors in the four-body leptonic decay of the meson (K) under the assumption of the unitary symmetry scheme by the perturbation theory of a Feynman diagram of a baryon-antibaryon closed loop. For the strong interaction, the pseudoscalar Yukawa interaction and the $|\Delta I| = \frac{1}{2}$ rule for the strangeness changing leptonic processes are assumed. (C.E.S.)

16627 INTERACTING SYMMETRY IN THE BOOTSTRAP MODEL. Akira Kanazawa (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 858-9(Nov. 1964).

The problem of whether the observed symmetries of strong interactions can be predicted in a framework of the dynamical S-matrix theory is discussed. The mass-degenerated pseudoscalar mesons π, K, and η and the degenerated vector mesons ρ, K^*, and ω, which are considered as resonances or bound states of the various pairs of pseudoscalar mesons in a bootstrap mechanism are considered. (C.E.S.)

16628 SU(3) SYMMETRY AND RELATION BETWEEN BARYONS AND LEPTONS. Sho Tanaka (Univ. of Helsinki). Progr. Theoret. Phys. (Kyoto), 32: 859-61(Nov. 1964).

A possibility for the physical basis of the eightfold way that makes close connection with the lepton family or the leptonic charge and takes into account the ideas of the Nagoya model and the quarks model is proposed. (C.E.S.)

16629 PRINCIPAL QUANTUM NUMBER FOR MESONS AND SELECTION RULES. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 861-3 (Nov. 1964).

The necessity for introducing a new integer quantum number n for mesons is considered. The quantum number n can be linked with the SU_3 symmetry. In the idealized limit of exact unitary symmetry the degenerate mass of each supermultiplet is determined by n alone, which is invariant under the SU_3 symmetry operations. New selection rules associated with the quantum number n are discussed. The assignments of the quantum number n to mesonic states are also presented. (C.E.S.)

16630 PRINCIPAL QUANTUM NUMBER FOR MESONS AND MASS SYSTEMATICS. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 863-5 (Nov. 1964).

Properties of the meson mass spectrum, which are mainly empirical, are pointed out. It is shown that the meson spectrum is largely covered by two branches of an integer multiplication rule. Mass relations for mesons are also derived. (C.E.S.)

16631 A NOTE ON HIGH ENERGY QUASIELASTIC PROTON-PROTON SCATTERING. Yoshio Takada and Masako Bando (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 865-6(Nov. 1964).

The previously proposed mechanism of diffraction scattering of a meson (π) in the cloud of a target nucleon from the incident projectile nucleon that was used to explain the features of high energy quasi-elastic proton-proton scattering is discussed, and an expression for the elastic π^-p differential cross section is presented. (C.E.S.)

16632 ELECTROMAGNETIC CORRECTIONS TO p-WAVE PHASE SHIFTS OF p-p SCATTERING. Shimon Mlin (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 904-10(Dec. 1964).

The scattering of two protons in the ^3P state is studied. The scattering amplitudes due to the electromagnetic corrections to the Coulomb interaction are derived in the Born approximation, and the contributions of these electromagnetic corrections to the p-wave phase shifts in the low-energy region are calculated. They turn out to be comparable to contributions due to vacuum polarization and should, therefore, be taken into account when results of experiments involving polarized protons are theoretically interpreted. (auth)

16633 G-PARITY AND UNITARY SYMMETRY. Kosai Tanabe and Hirotaka Sugawara (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 911-21(Dec. 1964).

In the SU(3)-symmetric theory of strong interaction, G-parity is generalized referring to the other subgroups U(2) of the U(3), called U and V-spins, different from the isotopic spin subgroup. The introduced G_U and G_V-parities are applied to obtain the selection rules for the $p\bar{\Sigma}^+$ and the $n\bar{\Sigma}^-$ annihilation processes. (auth)

16634 MASS FORMULA FOR BOSONS AND COMPOSITE MODEL. Shin Ishida (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 922-5(Dec. 1964).

Along the line of thought of the Sakata model it is shown that the mass difference among boson multiplets can be ascribed to the existence of the mass difference among ur-baryons, of which bosons are composed. (auth)

16635 ELEMENTARY PARTICLES AND INTERACTIONS. Pierre Hillion (Institut Henri Poincare, Paris). Progr. Theoret. Phys. (Kyoto), 32: 926-39(Dec. 1964).

The formalism is presented of a theory invariant under the direct product $P \times S\text{-}R_3$, where P is the Poincaré group and $S\text{-}R_3$ is the invariance group of strong interactions in the isospace $H(R_3^*)$. Although the domain of charge conjugation C is $H(R_3^*)$, the CPT theorem is proved. The formalism is extended to the group $P \times W\text{-}R_3$, where $W\text{-}R_3$ is the invariance group of weak interactions in $H(R_3^*)$. (auth)

16636 THE ROTATOR THEORY OF ELEMENTARY PARTICLES AND THE BARYON MASSES. F. Halbwachs (Faculte de Sciences, Marseille). Progr. Theoret. Phys. (Kyoto), 32: 940-9(Dec. 1964).

The relativistic rotator theory recently proposed for representing the elementary particles is considered. A comparison is established between the "internal" invariance group which lies at the basis of this theory and the Dirac spin group used in the "external" treatment. It is shown, in the framework of Yukawa's scheme, that the external group is the connected Dirac group, which can be split into two complex Pauli groups. In this frame, an internal Hamiltonian can be built. This Hamiltonian yields all observed strong interactions, besides unobserved ones, which would take place with the new unstable baryons introduced by the theory. From this Hamiltonian, the proper energies are derived in the usual way, and this treatment yields between the masses of the four known baryon multiplets a numerical relation which fits in exactly with the experimental data. (auth)

16637 SOME THEOREMS ON THE U-FUNCTIONS OF PARAMETRIZED FEYNMAN AMPLITUDES. Yutze Chow and Daniel J. Kleitman (Brandeis Univ., Waltham, Mass. and Harvard Univ., Cambridge, Mass.). Progr. Theoret. Phys. (Kyoto), 32: 950-5(Dec. 1964).

Several theorems concerning the so-called U-functions of parametrized Feynman amplitudes are developed by means of the topological properties of Feynman graphs. One of the theorems supplies a systematic means of calculating the U-function. Examples of the application of the theorem are given. (auth)

16638 EFFECTS OF MASS WIDTH OF BOSONS ON NUCLEON-NUCLEON SCATTERING. Susumu Furuichi, Shoji Sawada, Tamotsu Ueda, Wataro Watari, and Minoru Yonezawa (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 966-8(Dec. 1964).

The effects of the mass widths of bosons (scalar or vector) exchanged in N-N scattering are studied, assuming that the effects appear through a mass distribution in the transition matrix elements. (D.C.W.)

16639 NOTE ON INTERACTING SYMMETRY IN THE BOOTSTRAP MODEL. Naoki Tokuda (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 969-70(Dec. 1964).

It is shown that the set of vector mesons (ρ', K*, and ω), where ρ' differs from the meson (ρ) only by its G parity, does not lead to SU(3) in the bootstrap sense. (D.C.W.)

16640 SELF-CONSISTENT SCHEMES IN THE V-STRAP MODEL OF PS-PS SCATTERING. Naoki Tokuda and Akira Kanazawa (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 979-81(Dec. 1964).

The V($J = 1^-$)-strap model of the scattering of the mass-degenerate pseudoscalar mesons (π), (K), and (η) was studied in order to obtain all the possible self-consistent schemes. Assuming the mass degeneracy of the vector mesons V, it was shown that, besides the $8'$ and $10 + \overline{10}$ schemes, there are a number of other self-consistent schemes that do not belong to any of the irreducible representations of known simple Lie groups. (D.C.W.)

16641 INTERNAL SPACE OF BARYONS AND MESONS. Takehiko Takabayashi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 981-2(Dec. 1964).

A unified model for particles that is consistent with the SU(3) symmetry is obtained from the hypothesis that strongly interacting particles have hidden coordinates (ξ_i, η_i) with i = 1,2,3 in a real 3 + 3- dimensional space independent of the Lorentz space and that particles are oscillators in this internal space. The mean masses of the baryon octet and the decuplet baryons are predicted in good agreement with experimental values. (D.C.W.)

16642 DATA ON ELEMENTARY PARTICLES AND RESONANT STATES. Arthur H. Rosenfeld (Univ. of California, Berkeley). Angela Barbaro-Galtieri, Walter H. Barkas, Pierre L. Bastien, Janos Kirz, and Matts Roos. Rev. Mod. Phys., 36: 977-85(Oct. 1964). (UCRL-8030 (Pt.I))

Data are presented, in the form of graphs and tables, of the properties of elementary particles. The tables include the properties of stable particles, meson resonances, and baryon resonances. (T.F.H.)

16643 TAGGING SYSTEM FOR HIGH ENERGY PHOTONS. David O. Caldwell, John P. Dowd, Klaus Heinloth, and Michael D. Rousseau (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 36: 283-8(Mar. 1965). (MIT-2098-68)

An apparatus was built to determine the energy of each photon in a bremsstrahlung spectrum which produces an interaction of interest in a hydrogen target. The technique was applied specifically to charged pion photoproduction with photons of 2 to 5 Bev. The tagging system utilized a monoenergetic (to ±1%) positron beam which produced photons and associated recoil positrons in a thin radiator. The recoil positrons were momentum analyzed and detected by a 19-counter hodoscope. The difference between the energies of an incident and a recoil positron is the photon energy, and this was determined to ±2.5%. Since the photon beam is relatively weak, the interactions it produces must be detected with good efficiency. Such a large-solid-angle spark chamber, magnet, and counter system, which was used to measure the photoproduced pions, is also described. (auth)

16644 THE ELECTROMAGNETIC MASS-DIFFERENCES OF ELEMENTARY PARTICLES. Ning Hu and Guo-zheng Yang (Peking Univ.). Sci. Sinica (Peking), 14: 316-18(Feb. 1965).

It is shown that the electromagnetic mass differences of various hyperons calculated from the magnetic moments predicted by the SU(3) theory are in good agreement with experimental values. (D.C.W.)

16645 VISUAL INTERPRETATION OF CERTAIN PROPERTIES OF ELEMENTARY PARTICLES. B. I. Rusak. Uch. Zap. Tashkentsk. Gos. Ped. Inst., 38: 177-90(1963). (In Russian)

An original model of elementary-particle structure is examined. This model makes it possible to detect the relation between the mechanical and magnetic moments and their isotopic spin, strangeness, and intrinsic parity. Certain properties of elementary particles, such as the presence of magnetic moments in π^+ mesons and K^+ mesons, the presence of two mass variants of K mesons, and the value of parity in hyperons, can be predicted with this model. N magnetic moments can also be calculated approximately without introducing the arbitrary factor of dissociated state time. Particles and antiparticles can be distinguished without introducing artificial concepts of N charges, etc. The difference between particles and antiparticles can be reduced to the different types of spiral motion of neutrinos and antineutrinos found in all elementary particles. The model is a good basis for the calculation of interaction forces within an elementary particle and stability of particles. (Ref. Zh. Fiz. 1964)

16646 INELASTIC PROCESSES AT HIGH ENERGIES. M. P. Rekalo (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 48: 138-44(Jan. 1965). (In Russian)

Various inelastic processes at high energies are considered in that region of the other kinematic variables in which the asymptotic of the amplitudes is defined by fermion Regge poles. The amplitudes of the corresponding processes are obtained under the assumption that the structure of the amplitudes of elastic and inelastic processes are of single type and the amplitudes can be represented by specific pole diagrams describing region exchange. Relations between the asymptotic differential cross sections and a number of isotopic relations are derived by application of the single pole approximation. (auth)

16647 THERMODYNAMICS OF A ONE-DIMENSIONAL MODEL OF PARTICLES WITH A COULOMB INTERACTION. V. B. Magalinskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 167-74(Jan. 1965). (In Russian)

The statistical integral of the large canonical Gibbs distribution is investigated on basis of the occupation number representation. Exact formulas for the free energy and equation of state are obtained and investigated for a one-dimensional and single-component system of particles with Coulomb or Newton interaction. The possibility of an approximate investigation of the three-dimensional case is discussed. (auth)

16648 MOTION OF PARTIAL AMPLITUDE SINGULARITIES IN THE COMPLEX j PLANE. Yu. A. Simonov (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 242-52(Jan. 1965). (In Russian)

The origin, motion, and nature of the singularities of the partial scattering amplitude in the j plane are studied in detail by employing the explicit expression for the many-particle unitarity relations proposed by Gribov, Pomeranchuk, and Ter-Martirosian. It is demonstrated, in particular, that the singularities dependent on particle mass leave the first sheet in the j plane at threshold energy values. Assuming that the particles belong to definite Regge trajectories, it is possible to include the three-particle unitarity relation in the four-particle relation. Then the three-particle singularities also enter the second sheet along a four-particle branching in the j plane for $t_0 < (m + 2\mu)^2$. A similar situation is obtained if $(n-1)$-, $(n-2)$-particle unitarity relations are incorporated into the n-particle relation. Singularities in the j plane which appear if the expression for the Regge trajectories itself, $\alpha(t)$, possesses at some point t_0 a singularity or a zero derivative. (auth)

16649 ON THE POSSIBILITY OF EMISSION OF HARD VAVILOV-CHERENKOV RADIATION. V. V. Batygin (Kalinin Polytechnic Inst., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 272-4(Jan. 1965). (In Russian)

It is shown that hard photons may arise as a result of a two-quantum Vavilov-Cherenkov effect. Hard photon emission may be spontaneous as well as forced, the latter case arising under the action of soft photons. The spectrum and total intensity of forced radiation are determined. (auth)

16650 PROPAGATION AND EXCITATION OF ELECTROMAGNETIC WAVES IN A NONLINEAR MEDIUM. V. B.

Krosovitskii and V. I. Kurilko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 48: 353-7(Jan. 1965). (In Russian)

Propagation of a large amplitude transverse wave in a two-level system is considered. A nonlinear dispersion equation for such waves is derived and investigated. It is shown that under certain conditions the transverse wave is unstable with respect to parametric excitation of a longitudinal wave with the same phase velocity. The problem of excitation of a two-level system by an electron beam is investigated. It is shown that if the anomalous Doppler effect condition is met the system may be transformed to the inverted state. Coupled nonstationary longitudinal-transverse oscillations in the beam-active medium system are considered. (auth)

16651 NUCLEON-NUCLEON SCATTERING AT LOW ENERGIES. S. N. Biswas (Tata Inst. of Fundamental Research, Bombay). p.1-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The experimental situation in low-energy N-N scattering is reviewed. It is concluded that $^1D_2$ phases are large and positive while the $^1S_0$ phase changes sign at 250 Mev, indicating a repulsive short-range potential which simulates the effect of a hard core surrounded by long-range attractive potential more intense than that of the one-pion-exchange contribution. It is found that all triplet phases to ^3F have the same sign as given by the OPEC tensor force, while the $^3P_0$ phase changes sign at 200 Mev and remains negative at higher energy, showing the presence of a repulsive short-range LS force. Theoretical work on the N-N interaction, using the theory of strong interactions based on unitarity and analyticity, is reviewed. (M.J.T.)

16652 MEASUREMENT OF NEUTRON FORM FACTOR FROM INELASTIC ELECTRON-DEUTERON SCATTERING. S. K. Bose (Tata Inst. of Fundamental Research, Bombay). p.18-20 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The interaction $e + d \rightarrow e + n + p$ is used to determine the electromagnetic form factor of the neutron. Feynman diagrams are used to derive the contribution of the pole at $t = m^2$ to the scattering amplitude. An extrapolation formula is obtained for the form factor, which may then be determined from the measured differential cross section by Chew-Low extrapolation. (M.J.T.)

16653 LECTURES ON WEAK INTERACTIONS OF STRONGLY INTERACTING PARTICLES. Murray Gell-Mann. Bombay, Tata Inst. of Fundamental Research, 1961. 143p.

A brief review of the theory of weak interactions of the strongly interacting particles is first presented. The charge and isotopic-spin properties, as well as the dynamical nature of weak interactions are considered. The matrix elements of the weak and electromagnetic currents between the states of the strongly interacting particles are then treated using dispersion theory. The baryon and meson states and the currents in the different interactions are described on the basis of unitary symmetry. (D.C.W.)

16654 MEZHDUNARODNAYA ZIMNYAYA SHKOLA TEORETICHESKOI FIZIKI PRI OB'EDINENNOM INSTITUTE YADERNYKH ISSLEDOVANII. KURS LEKTSII. TOM III. (National Winter Semester School of Theoretical Physics at the Joint Institute for Nuclear Research. Vol. III, 1964). Dubna, USSR, Joint Inst. for Nuclear Research, 1964. 195p.

Separate abstracts were prepared for the ten papers included. (D.C.W.)

For abstracts of individual lectures see: 16655, 16656, 16657, 16658, 16659, 16660, 16661, 16662, 16725, and 16726.

16655 TECHNIQUES FOR SU(3) GROUP. V. I. Ogievetskii. p.5-25 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

In order to classify systematically the ever-growing number of elementary particles and resonances, new and broader symmetry properties, such as the conservation of the parity of isospin and strangeness, proposed by Gell-Mann and Nishijima, must be used. The discovery of the Ω particles indicates that the introduction of the three-fold unimodular SU(3) group in Gell-Mann's concept could be expected to yield good results in this respect. Therefore, the symmetry system of the SU(3) group was examined, studying the multiplets involved in the SU(3) invariance, together with their isospin and hypercharge. It is concluded that Gell-Mann and Neeman's explanation of the symmetry of strong interactions is satisfactory, using the invariance for the classification on the basis of multiplets and including data on known particles and resonances. The results are in good agreement with experimental findings. (TTT)

16656 APPLICATIONS OF POLARIZED PROTON TARGET IN HIGH ENERGY PHYSICS. S. M. Bilen'kii, L. I. Lapidus, and R. M. Ryidin. p.26-39 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Two aspects of the polarized proton targets were reviewed: determination of the internal parity of strange particles and the application of these targets for the measurement of the polarization effects in various reactions. Several effects which can not be determined by any other method, such as spin measurements in the π-p scattering, may be determined by this method. These measurements contribute to the deeper understanding of the spin dependence in elementary particle interactions. Single crystals of the 24-hydrated double nitrate of La and Mg, $La_2Mg_3(NO_3)_{12}\cdot 24H_2O$ were used as the target in all the experiments. About 1% of the La^{3+} ions in the crystal were exchanged for the paramagnetic Ce^{3+} or Nd^{3+} ions; the effective spin of the electron shell of these ions is $s = \frac{1}{2}$. The protons of the water of crystallization were polarized dynamically, involving the saturation of the "forbidden" paramagnetic transition. The parity of the strange particles was successfully determined by means of a polarized proton target in the following reactions: $\pi + p \rightarrow \Lambda\ (\Sigma) + K$; $\bar{K} + p \rightarrow \Lambda\ (\Sigma) + \pi$; $\bar{K} + p \rightarrow \Xi + K$. The method was used to measure the asymmetry in the scattering of 246-Mev mesons (π^+) by polarized protons. The targets were also used for polarization studies in (n-p) scattering by determining the asymmetry of the recoil protons in experiments with non-polarized protons. (TTT)

16657 PRINCIPAL CHARACTERISTICS OF BOSON RESONANCES. V. G. Grishin. p.40-53 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institut Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The currently authenticated boson resonances and their basic properties, such as strangeness, isotopic spin, spin, parity, level width, decay scheme and the relative decay probability were tabulated. The meson (ρ), meson (f), meson (ω), meson (η), meson (φ) and meson (K*) are discussed in detail. On the basis of the resonances, the symmetry of all the properties of the particles was established, correlating a large number of particles and a limited number of multiplets on the basis of the models developed by Gell-Mann and Neeman. The resonance phenomena are considered just as much a fundamental question as the problem of elementary particles or the theory of interaction. (TTT)

16658 FERMION RESONANCES. I. V. Chuvilo. p.54-85 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

In addition to the boson particles, there is also a large class of similar fermion particles. Cases are examined, in which the experimentally measured energy width of a resonance state is always markedly higher than the re-

solving power of the method used for the study. The order of magnitude of these widths ranges from (0.1 to 1.0) × $m_\pi c^2$, where m_π = mass of the meson (π). Thus, the order of magnitude of the lifetime of the resonance states is equal to or smaller than the characteristic nuclear lifetime of 10^{-23} sec; the decay is due to strong interactions rather than to electromagnetic transitions as in the case of the decay of meson (η^0) in fermion resonances. One of the decay products is always a baryon-type fermion particle with a ½ spin. In view of the conservation of the strangeness and the baryon number in strong interactions, the quantum number S of strangeness is assumed to be equal to the sum of the strangeness quantum numbers of the final decay particles of the resonance state. It is also assumed that the isotopic spin number is conserved. Isobars with S = 0, −1, and −3 were examined during the study of baryon isobars, carried out for the purpose of defining the quantum number of particles. It is not yet possible to solve satisfactorily the problem of the distribution of particles according to unitary multiplets. The fermion resonances are tabulated, giving their isotopic spin, spin and parity, strangeness, mass level width and decay scheme. (TTT)

16659 INTRINSIC STRUCTURE OF ELEMENTARY PARTICLES. V. S. Barashenkov. p.86-105 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Recent theories on the internal structure of elementary particles are reviewed. Form factors, which are drawn in analogy to molecular, atomic, and nuclear physics, are discussed. The electric and magnetic form factors are taken as sums of Pauli and Dirac form factors. As an idealization, the constant parts of the form factors are taken as sums of δ-functions. The analysis of Hofstadter is discussed. This analysis agrees with experimental data only if the mass of the meson (ρ) is taken as 600 Mev, which is much less than its measured value (750 ± 10 Mev). Also, the analysis does not consider the π-π resonance with a mass of 395 ± 10 Mev. The charge form factor F(q) calculated with Hofstadter's constants is equal to 0.02−0.03 in the range $q^2 = 0 - 2 \times 10^{26}$ cm^{-2}. However, from other measurements in the range $q^2 = 0.3 - 2.2 \times 10^{26}$ cm^{-2}, F(q) is practically zero. A possible explanation of this discrepancy is advanced. Methods of obtaining information on electromagnetic deformation of a nucleon by e-p, e-d, and n-e scattering are discussed. In some cases better information can be obtained from gamma scattering. Internally the nucleon may be viewed as a tight kernal surrounded by a loose peripheral cloud. Pion-nucleon resonances may be viewed as excited states of the nucleon. The possibility of a similar explanation of pion-hyperon and hyperon (Σ) resonances is discussed. (TTT)

16660 ON CERTAIN POSSIBLE EXPERIMENTS WITH HIGH-ENERGY NEUTRINO. L. B. Okun. p.106-17 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Five possible experiments with neutrino beams are discussed which would give useful information on weak interactions: the search for the boson (W) and a study of its properties; a study of processes which depend on the square of the neutrino flux; a study of the electromagnetic form factor of the neutrino; a study of isotopic and dynamic properties of baryon fluxes; and a search for new kinds of particles and interactions. The second set of experiments is only of interest if the meson (W) can not be found. These processes include the decay of a muon neutrino ν_μ into another $\nu_\mu + \mu^+ + \mu^-$. Neutrino beams of energy $E_\nu = 2$ Bev are required which can give good statistics for processes with cross sections ranging from 10^{-41} to 10^{-42} cm^2. To obtain "pure" neutrino fluxes the charged particles in the neutrino beam can be removed magnetically. Otherwise troublesome mesons can be removed because of their short lifetimes. (TTT)

16661 EFFECTS OF WEAK INTERACTIONS ON ELECTROMAGNETIC PROPERTIES OF PARTICLES. A. M. Perelomov. p.118-31 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

According to present theories, the electromagnetic properties (EMP) of a particle are determined entirely by its charge distribution. The largest differences from the EMP of a free particle occur in a particle involved in a strong interaction. The effects of weak interactions usually give only corrections of the order α (the fine structure constant). If the weak interactions do not conserve parity, new types of EMP arise. Experimental data on the charge, magnetic moment, and charge radius of neutrinos are summarized, and the arguments that all of these parameters should be zero are reviewed. Equations for the neutrino form factor are derived under three different assumptions: only those interactions exists which lead to experimentally observed processes (β decay, μ decay, and μ absorption); the Lagrangian of the weak interactions have the form of the product of the fluxes (Feinman-Gell-Mann Theory); and the meson (W) exists. While new EMP arise from weak interactions with all particles, the EMP can only be calculated for the electron and meson (μ), where the change in the EMP due to weak interactions is of the order of α^3. (TTT)

16662 LORENTZ GROUP AND INTEGRAL CONCEPTS. Ya. A. Smorodinskii. p.179-96 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The coordinate systems used to study reactions of the form A + B → C + D, where momentum is conserved, are discussed. In nonrelativistic cases cartesian, cylindrical, or spherical coordinates are used; the outgoing wave functions are expanded in the appropriate eigenfunctions of the Laplacian operator. In relativistic cases, a concomitant 4-vector velocity coordinate system is used in Minkovsky space, which is related to the Mandelstam parameters. If only the angular distribution of the particles is considered for cases of axial symmetry, then the coordinate surfaces are spheres in Lobachevsky space. Depending on the curvature of the Lobachevsky space, four types of coordinate systems may be used: spherical, hyperboloid, orispherical, and cylindrical. For each system are given the transformations to Lobachevsky space, the expansion of the Laplacian operator, and the integral expansion of the eigenfunctions of the Laplacian operator. Non-unitary expansions are also discussed. The matrices describing the transmitted momentum are given for each system. The effects of including the particle spin are discussed. Cross-transformations are obtained in the development of the simple geometric interpretations. (TTT)

16663 FURTHER EVIDENCE FOR A MOLECULAR STRUCTURE OF HEAVY MESONS. E. J. Sternglass (Westinghouse Research Labs., Pittsburgh). 13p. (CONF-640603-3)

From Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio.

It was previously shown that the masses and spins of the heavy mesons and meson (π) resonances are well explained by a quasi-molecular rotator model composed of mesons (π) with bond-length and binding energy per bond determined from an electron pair model of the meson (π^0). The extent is shown to which this model was substantiated by the subsequent observation of meson (π) resonances that fit the next highest rotational levels of these structures with respect to energy, angular momentum, and relative intensity. (D.C.W.)

16664 RESULTS OF TOPTYGIN'S THEORY OF ELECTRON POLARIZATION AFTER MULTIPLE SCATTERING. A. J. Dufner and A. V. Bushkovitch (St. Louis Univ.). 6p. (CONF-640606-12)

From American Physical Society Summer Meeting, Denver.

The effect of multiple scattering on the polarization vector in double Mott scattering was studied in the Toptygin theory, with specific consideration of Al and Au scattering foils. (D.C.W.)

Field Theory and Quantum Mechanics

Refer also to abstracts 15986 and 17025.

16665 (JINR-D-1929) SU(6)-SYMMETRY AND ITS POSSIBLE GENERALIZATIONS. V. G. Kadyshevskii (Kadyshevsky), R. M. Muradyan, A. N. Tavkhelidze, and I. T. Todorov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep.(mn).

A possible generalization of the Lie algebra of SU(6) group is considered, which takes into account higher angular momenta. A 108-parametrical group G is proposed in which the Poincaré group and internal U(3) symmetry group are joined together, the SU(6) group being contained as a subgroup in it. (auth)

16666 (JINR-P-1928) O DOPUSTIMOI SKOROSTI UBYVANIYA AMPLITUDY RASSEYANIYA VPERED PRI BOL'SHIKH ENERGIYAKH. (On the High-Energy Lower Bound of the Forward Scattering Amplitude). R. Wit (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 8p. Dep.(mn).

The Phragmén-Lindelöf theorem and the theory of Herglotz functions are used for the investigation of the high-energy lower bound of the forward scattering amplitude. As an application, the incompatibility of the two-particle unitarity condition with the analytic properties of the Lee Model is proven. (auth)

16667 (TID-20517) PERTURBATION THEORY OF PARTIAL WAVE AMPLITUDES. Norman Howard Fuchs (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [Apr. 13, 1964]. Contract AT(30-1)-2098. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Analytic properties of field-theoretic partial-wave scattering amplitudes, considered as a function of complex angular momentum, are investigated in the framework of term-by-term perturbation theory. The interaction of spinless, equal-mass bosons only is considered, although the basic method is more generally applicable. In simple cases, the analytic behavior over the entire finite l-plane is determined; for more complex Feynmann diagrams, results are limited to a half-plane. The only singularities encountered are poles occurring exclusively at negative integers. (auth)

16668 WEAK INTERACTIONS AND HIGHER SYMMETRIES. Proceedings of the III International Hochschulwochen fur Kernphysik 1964 der Karl-Franzens-Universität Graz, at Schladming (Steiermark, Austria) 24th February–7th March 1964. Paul Urban, ed. Acta Phys. Austriaca, Suppl. I, 1-255(1964). Vienna, Springer-Verlag, 1964. (CONF-640203)

Separate abstracts were prepared for 13 of the 17 papers presented; 3 papers are given in abstract form only, and the remaining paper was previously abstracted for NSA (19:8246) as part of a lecture on strong and electromagnetic interactions. (R.E.U.)

For abstracts of individual papers see: 16669, 16670, 16671, 16672, 16673, 16674, 16675, 16676, 16677, 16678, 16679, 16680, and 16681.

16669 LECTURES ON LIE ALGEBRAS FOR PHYSICISTS. H. Joos (Deutsches Elektronen-Synchrotron, Hamburg). Acta Phys. Austriaca, Suppl. I, 3-18(1964).

A discussion is given of compact real semisimple Lie algebras as associated with the mathematics of Lie groups used for commutation relations for observables in SU(3)-symmetry and weak-interaction theory. (R.E.U.)

16670 SU(3) INVARIANT STATIC MODEL. J. E. Wess. Acta Phys. Austriaca, Suppl. I, 68-80(1964).

The performance of the SU(3) model in describing the dynamics of baryon–meson systems is discussed mathematically. A matrix representation is used in the derivation of projection operators, which project into the invariant subspaces of the 8 and 8′ representations of $8 \otimes 8$. Some experimental results are compared with predictions of the static model involving SU(3) invariance. (R.E.U.)

16671 PROBLEMS ON CONSERVATION AND LACK OF CONSERVATION OF WEAK INTERACTION CURRENTS. R. Vinh Mau. Acta Phys. Austriaca, Suppl. I, 81-91(1964).

Renormalization problems in μ-meson decays ($\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$) and in weak interactions involving both leptons and strongly interacting particles are discussed in terms of a phenomenological model of weak interactions. Conservation of the vector part of the weak interaction current is discussed, and the weak interaction matrix is obtained from the electromagnetic form factors. The "weak magnetism" term in the vector matrix element is discussed. Lack of conservation and asymptotic conservation of the axial vector current are considered. (R.E.U.)

16672 DYNAMICAL CONSEQUENCES OF SYMMETRIES AMONG ELEMENTARY PARTICLES. H. Pietschmann. Acta Phys. Austriaca, Suppl. I, 92-5(1964).

The dynamical consequences of I-spin invariance grouping in weak interactions are discussed in an effort to obtain information on dynamic entities (such as amplitudes or form factors) purely from the symmetry properties of the elementary particles. (R.E.U.)

16673 UNITARY SYMMETRY AND THE LEPTONIC DECAYS OF HADRONS. D. Horn (Tel Aviv Univ., Israel). Acta Phys. Austriaca, Suppl. I, 96-105(1964).

The structure of the weak currents that appear in the leptonic decays is discussed in the light of unitary symmetry. The known leptonic interaction modes imply the inclusion of more currents than the ones derived from gauge invariance of the octet model. It is therefore suggested that the weak currents emerge from a higher symmetry scheme. The vector part of the interaction is obtained by CVC arguments and the axial-vector part by a Goldberger-Treiman approach. The fit with the experimental situation is discussed. (auth)

16674 LEPTONIC DECAY OF HADRONS. PART II. CABIBBO'S THEORY. D. Horn (Tel Aviv Univ., Israel). Acta Phys. Austriaca, Suppl. I, 106-7(1964).

Current conservation under transformation in the octet representation for currents of the form $|\Delta T| = 1$ and $\frac{1}{2}$ is discussed in the realm of Cabibbo's theory. (R.E.U.)

16675 SYMMETRIES OF LEPTONS. D. Horn (Tel Aviv Univ., Israel). Acta Phys. Austriaca, Suppl. I, 110-15(1964).

Symmetry classifications for the muon and electron are discussed. Various quantum numbers are derived. (R.E.U.)

16676 A FORMULATION FOR THE TWO NEUTRINO FIELDS IN THE SU(3). T. Toyoda (Rikkyo Univ., Tokyo). Acta Phys. Austriaca, Suppl. I, 116-33(1964).

Two-neutrino field theories are discussed in the framework of SU(3). An equivalence between Gatto's method and that of Marshak, Ryan, Radha, and Raman is shown by postulating that the two distinct neutrino fields are two independent Majorana fields, which obey different Touschek transformations. (R.E.U.)

16677 PROPAGATOR OF VECTOR BOSONS. Walter Thirring. Acta Phys. Austriaca, Suppl. I, 138-41(1964).

The propagator for vector particles is examined within Lagrangian field theory. Coupling of the vector field to a nonconserved current is considered. (R.E.U.)

16678 THE FIELD THEORY OF THE INTERMEDIATE BOSON IN WEAK INTERACTIONS. W. Kummer (CERN, Geneva). Acta Phys. Austriaca, Suppl. I, 142-51(1964).

An introduction into the theory of the intermediate vector boson (W) is given, and information extraction is discussed. The "peratization" method of Feinberg and Pais is considered for a higher order field theory. (R.E.U.)

16679 HIGHER APPROXIMATIONS TO WEAK INTERACTIONS. G. Domokos (CERN, Geneva). Acta Phys. Austriaca, Suppl. I, 153-82(1964).

Higher order corrections to weak interactions involving four fermions are described by means of the Bethe-Salpeter equation with some approximations by means of simple diagrams. (R.E.U.)

16680 RACAH-COEFFICIENTS OF SU_3 FOR $8 \otimes 8 \otimes 8$ AND $8 \otimes 10 \otimes 8$. Margarete Krammer (Universität, Graz). Acta. Phys. Austriaca, Suppl. I, 183-8(1964).

Racah coefficients (6-j symbols) of SU(3) were calculated and compiled in terms of orthogonal matrices. The direct product $\mu_1 \otimes \mu_2 \otimes \mu_3$ is reduced to $(\mu_1 \otimes \mu_2) \otimes \mu_3$ and $\mu_1 \otimes (\mu_2 \otimes \mu_3)$ and the Clebsch-Gordan coefficients of the SU(3) are split in their isoscalar factors. (R.E.U.)

16681 WEAK INTERACTIONS WITHOUT CHANGE OF STRANGENESS (EXPERIMENTAL). H. Faissner (CERN, Geneva). Acta Phys. Austriaca, Suppl. I, 189-255(1964).

A review is presented of high-energy neutrino experiments performed recently at CERN: neutrino beam production, detection and identification of neutrinos, qualitative descriptions, elastic processes, existence of intermediate vector boson (W), and some low momentum transfer results. (R.E.U.)

16682 ON A CLASS OF EXPLICIT REPRESENTATIONS OF THE HOMOGENEOUS LORENTZ GROUP. Arne Kihlberg (Chalmers Tekniska Hogskola, Goteborg). Arkiv Fysik, 27: 373-82(1965).

A class of explicit, irreducible, unitary representations of the homogeneous Lorentz group is given. It is explicit in the sense that the Hilbert space is a certain function space over a carrier space. As the carrier space the four-dimensional space of restricted six-vectors $(e,h|e \cdot h = 0, e^2 = h^2)$ is chosen. The class is complete in the sense that any irreducible, unitary representation is unitarily equivalent to one in the class. (auth)

16683 GAUGE-INDEPENDENT THEORY OF SYMMETRY. [PART] I. L. J. Tassie and H. A. Buchdahl (Australian National Univ., Canberra). Australian J. Phys., 17: 431-9(Dec. 1964).

The invariance of a system under a given transformation of coordinates is usually taken to mean that its Lagrangian is invariant under that transformation. Consequently, whether or not the system is invariant will depend on the gauge used in describing the system. By defining invariance of a system to mean the invariance of its equations of motion, a guage-independent theory of symmetry properties is obtained for classical mechanics in both the lagrangian and hamiltonian forms. The conserved quantities associated with continuous symmetry transformations are obtained. The system of a single particle moving in a given electromagnetic field is considered in detail for various symmetries of the electromagnetic field, and the appropriate conserved quantities are found. (auth)

16684 MOTION OF A CHARGED PARTICLE IN A NONUNIFORM MAGNETIC FIELD. R. F. Mathams (Univ. of Queensland, Brisbane). Australian J. Phys., 17: 547-52 (Dec. 1964).

The definition of an electron trajectory as a superior trochoid and the subsequent calculation of the nonuniform magnetic field to produce this trajectory leads to much simpler equations than the converse process of computing a trajectory in a defined nonuniform field. Magnetic fields having variations very close to the exact form are readily produced by inclined pole faces. Correlated equations were derived which relate these magnetic fields, and their electron-optical properties were discussed. (C.E.S.)

16685 SIMPLIFIED PHENOMENOLOGICAL TREATMENT OF THE NUCLEON OF RESONANCE STATE ($N^*_{\frac{3}{2}}$). I. PROJECTION OPERATORS OF THE PARTICLE OF SPIN $\frac{3}{2}$. Philippe Leruste (College de France, Paris). Cahiers Phys., 18: 189-200(May 1964). (In French)

With the aim of using a systematic method of calculation based upon the cutting of Feynman graphs for processes with N^* formation, projection operators for the various quantum states of the spin $\frac{3}{2}$ particle were constructed in a covariant manner. (auth)

16686 SIMPLIFIED PHENOMENOLOGICAL TREATMENT OF THE NUCLEON OF RESONANT STATE ($N^*_{\frac{3}{2}}$). II. APPLICATION TO THE CALCULATION OF REACTIONS. Paul Kessler (College de France, Paris). Cahiers Phys., 18: 201-8(May 1964). (In French)

Starting from a field-theoretical generalization of the Breit & Wigner formula, a method that allows a simplification of the treatment of certain reactions with N^* formation is established. Using the projection operators defined in part I, this method is applied to the calculation of various processes: pion nucleon scattering, photoproduction, Compton effect. Our treatment can in principle be extended to other resonances, and can also be applied to certain problems of electrodynamics. (auth)

16687 ON THE QUESTION OF THE UNIQUENESS OF THE ENERGY-MOMENTUM COMPLEX IN THE SPECIAL AND GENERAL THEORY OF RELATIVITY. J. Bicak (Charles Univ., Prague). Czech J. Phys., 15: 81-94(1965).

A modification of the Fock method is used to look systematically for the complexes of energy and momentum which are conserved as a consequence of the vacuum field equations of the second order (real and complex scalar field, real vector field, symmetric tensor field of the linearized and non-linear Einstein theory). In contrast to Fock's results for fields described by equations of the first order, the complexes are not defined uniquely. The non-ambiguities are eliminated by supplementary conditions. (auth)

16688 A NOTE ON THE SPECIAL THEORY OF RELATIVITY. Zlatko Jankovic (Univ. of Zagreb and Institute "Ruder Boskovic," Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 19: 75-86(1964).

The Lorentz-Einstein transformations for a flat Euclidean three-dimensional space assuming isotropy and homogeneity are deduced in vector form. Particle mechanics, e.g., Lagrangian and Hamiltonian functions, is considered. (R.E.U.)

16689 RADIATION SPECTRUM DUE TO PERIODIC MOTION IN A PERIODICALLY-INHOMOGENEOUS MEDIUM. B. V. Khachatryan (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 17: No. 5, 103-7 (1964). (In Russian)

The previous derivation of the spectrum for uniform motion of an oscillator in a medium with a sinusoidally varying dielectric constant is considered. The calculations are repeated for an arbitrarily periodic medium, starting from an expression for the vector potential in an inhomogeneous medium. The final expression for the spectrum is similar to that obtained in the earlier derivation, and the two spectra are identical when the direction of the oscillator is parallel to that of the periodicity of the inhomogeneity of the medium. (ATD)

16690 APPROXIMATIONS TO ENERGY-LEVEL DISTRIBUTIONS. Chava Lifshitz and Max Wolfsberg (Cornell Univ., Ithaca, N. Y. and Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 41: 1879-80(Sept. 15, 1964). (BNL-7981)

Previously obtained exact values of S(E), the number of energy levels with energy less than E above the ground state, are presented for a system of n harmonic quantum oscillators. Effective zero point energies in classical S(E) expressions for rotors and also more accurate functional expressions for S(E) are considered. Semiclassical expressions for quantized systems of n two-dimensional rigid rotors and n one-dimensional rotors are obtained, and computer counted values for S(E) and zero point energy are shown. The zero point energy values are rationalized using the Euler-Maclaurin formula in a method developed by Haarhoff. S(E) values obtained using the Haarhoff formulas

are compared with the other values. It is concluded that the Haarhoff procedure yields a good approximation for S(E) at sufficiently high E for the rotors, and that an effective zero point energy in a semiclassical level distribution expression is not necessarily related to a quantum-mechanical zero point energy. (M.J.T.)

16691 APPRAISAL OF THE FOPIM FAST-CONVERGING PERTURBATION METHOD. Peter D. Robinson, John H. Huntington, and Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). J. Chem. Phys., 42: 1879-83 (Mar. 15, 1965).

The practicality of the first-order perturbation-iteration method (FOPIM) was appraised. After the first iteration, the expectation value of the energy is given by a nonanalytic function of the perturbation parameter λ. The asymptotic expansion of this function gives the energy accurately up to $0(\lambda^5)$. The convergence of the asymptotic expansions is discussed. Two examples are considered: a perturbed ground-state hydrogen atom and a perturbed ground-state linear harmonic oscillator. (auth)

16692 QUANTUM STATISTICS OF MULTICOMPONENT SYSTEMS. Franz Mohling and W. T. Grandy, Jr. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 6: 348-79 (Mar. 1965).

Methods of quantum statistics are applied to the general multicomponent system, and explicit rules for the calculation of thermodynamic quantities and distribution functions in terms of the basic particle interactions are derived. Particular attention is given to the nonrelativistic system of charged particles, and several inherent difficulties are investigated and treated. Included are the renormalization, by the Λ transformation, of charged-particle energy contributions due to the emission and reabsorption of photons and the formal sum over all long-range Coulomb effects wherever (diagrammatically) they give divergent expressions. The latter sum is shown to result in the familiar Debye-Hückel theory in the high-temperature, low-density limit. (auth)

16693 QUANTUM MECHANICS OF A MANY-BOSON SYSTEM AND THE REPRESENTATION OF CANONICAL VARIABLES. Hiroshi Ezawa (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 6: 380-404(Mar. 1965).

A method of treating the assembly of interacting bosons under Bose-Einstein condensation is presented. Without applying the Bogoliubov approximation in which the creation and the annihilation operators of zero-momentum particles are replaced by a c number, the quantum nature of these operators is retained. The method is a quantum mechanical adaptation of the theory of small oscillation. The oscillation means the fluctuation of the number of condensed particles. The interaction between particles determines the stability of this oscillation. When it is stable and its amplitude is not macroscopic, the Bogoliubov approximation is valid. In this way, the method provides a validity criterion for the Bogoliubov approximation as well as an estimation of the errors thereby committed. It is noted that the excitations associated with the fluctuation of condensed particles can never be obtained within that approximation. The method is applied to the Huang model, the assembly of bosons interacting through a hard core plus weak attractive potential. Having found that, within the physically accessible range of the particle density, the above-mentioned oscillation is stable, it is concluded that Huang's treatment is well founded. The mathematical background of the approximation is discussed by invoking the representation theory of canonical variables of an infinitely large system. (auth)

16694 LEPTON SCATTERING AMPLITUDES IN TWO MODEL FIELD THEORIES. G. W. Erickson (New York Univ., New York) and H. M. Fried. J. Math. Phys. (N. Y.), 6: 414-23(Mar. 1965).

Two lepton-lepton scattering amplitudes are considered within the context of a no-recoil Bloch-Nordsieck model, with emphasis on the singularities in that configuration-space variable conjugate to momentum transfer. For the interaction $\mathscr{V}' = -g\bar{\psi}A\psi$, renormalizable in four dimensions, and in the approximation of including only the exchange of all possible bosons between a pair of leptons, a light cone singularity no worse than that of the one-boson-exchange graph is found. Similar statements may be made for the same interaction, nonrenormalizable in six dimensions, provided certain continuations in the center-of-mass energy variable are employed; otherwise, an essential singularity appears. A remark illustrating the formation of bound states is made for the renormalizable interaction. No argument is given to establish the relevance of these models to the actual field-theoretic situations. (auth)

16695 TRANSFORMATION HAVING APPLICATIONS IN QUANTUM MECHANICS. H. Heffner (Stanford Univ., Calif.) and W. H. Louisell. J. Math. Phys. (N. Y.), 6: 474-8(Mar. 1965).

By properly ordering functions of noncommuting operators, a one-to-one transformation between operator functions and corresponding functions of commuting algebraic variables can be made. With this transformation, boson operator equations such as the Schroedinger equation can be converted to differential equations for the transformed functions, the resulting equations containing solely commuting variables. Once the solution to the transformed equation is obtained, the inverse transformation may be applied to yield the solution to the original operator equation. The method is extended to include angular momentum operators. (auth)

16696 THE QUANTUM MECHANICAL THREE-BODY PROBLEM AND ITS APPLICATION TO NONLINEAR, TRIATOMIC MOLECULES. A. Weiguny (Universitat, Freiburg i. B.). J. Mol. Spectry., 15: 1-14(Jan. 1965)

The main problem in the theory of the rotational and vibrational levels in triatomic molecules is the introduction of a suitable coordinate system. After separation of the center-of-mass motion, a set of normal coordinates describing the oscillations and three Eulerian angles defining the orientation of a "body-fixed" coordinate system in space are introduced. Since the molecule has no rigid configuration, the body-fixed system can be defined in different ways. Studies were made with the body-fixed system chosen to be the instantaneous system of principal axes of inertia. This led, however, to serious difficulties in interpretation of the moments of inertia as mentioned by Eckart in 1934. It is shown how these difficulties may be overcome by means of a unitary transformation. Results of the theory are found to be in agreement with those of the former theory with some differences concerning definition of the empirical parameters. (auth)

16697 NONRADIATING OSCILLATION OF CHARGE. G. A. Perkins. Nuovo Cimento (1), 2: 276-92(1964).

Efforts to re-examine or modify electromagnetic theory to account for the Bohr hypothesis that charges can oscillate in stationary states without producing radiation are outlined. These efforts were based on the assumption that $\vec{J} = \vec{v}\rho$. An examination that uses Maxwell's equations without commitment as to the truth or falsity of the assumption $\vec{J} = \vec{v}\rho$ is outlined. It is shown that a certain condition, expressed in terms of the polarization, is consistent with charge oscillation but not with the production of radiation. The applicability of that restriction is discussed in general and specifically with reference to the free electron field using the Dirac equation. (C.E.S.)

16698 THE CLEBSCH-GORDAN PROBLEM IN CARTESIAN FORM. B. Barsella and E. Fabri (Universita, Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (1), 2: Suppl., 293-309(1964).

An extensive treatment of Cartesian irreducible tensors (of integral and half-integral order) is given. The Cartesian representation of an irreducible tensor is necessarily redundant, i.e., some identities exist among its components, but definite rules are given which describe how to extract all irreducible parts from the product of two irreducible tensors. One side of the complete Clebsch-Gordon problem, that is, the building up of irreducible tensors from

the product of two irreducible tensors of any order, is solved. (C.E.S.)

16699 RENORMALIZATION IN A FIELD THEORY ENDOWED WITH A HIGH MOMENTUM CUT-OFF. R. J. Genolio (St. John's Univ., New York). Nuovo Cimento (10), 35: 838-51(Feb. 1, 1965).

In stochastic field theory, which has a high momentum cut-off and therefore no u-v divergences, renormalization is used to determine an S-operator that leaves single-particle states unchanged or steady. A renormalization scheme is formulated for stochastic quantum electrodynamics that insures steadiness for all momenta. Finite renormalization parameters are determined that are, in general, momentum-dependent and not scalar. These define a nonlocal renormalized interaction Lagrangian in configuration space. (auth)

16700 A SIMPLE EXAMPLE OF SYMMETRY VIOLATION. O. Hara and T. Goto (Nihon Univ., Tokyo). Nuovo Cimento (10), 35: 867-71(Feb. 1, 1965).

It is pointed out that the Yang-Mills field which lacks the nonlinear term gives a very simple example of symmetry violation. (auth)

16701 THE INHOMOGENEOUS PSEUDO-ROTATION GROUP AS A LIMITING CASE OF A (HOMOGENEOUS) PSEUDOROTATION GROUP OF ONE MORE DIMENSION. J. Rosen (Tel-Aviv Univ., Israel). Nuovo Cimento (10), 35: 1234-5(Feb. 16, 1965).

It is shown that the translations of an inhomogeneous pseudo-rotation group can be interpreted as rotations into an extra dimension in the limit of the vanishing of the extra metric component. (D.C.W.)

16702 ON THE MOTION OF QUANTIZED ELECTRIC FLUX LINES AND NONEXISTENCE OF MAGNETIC MONOPOLES. G. Cavalleri (CISE, Milan). Nuovo Cimento (10), 35: 1236-9(Feb. 16, 1965).

A model for describing the motion of the electric flux lines of a point charge is outlined in which the motion of the magnetic flux lines is considered to be unphysical, thereby excluding their materialization and the existence of the monopoles. (D.C.W.)

16703 PERATIZATION VS. RENORMALIZATION IN WEAK-INTERACTION THEORY. W. Guettinger, R. Penzl, and E. Pfaffelhuber (Universitat, Munich). Nuovo Cimento (10), 35: 1247-50(Feb. 16, 1965).

A peratization scheme is outlined, which renders the Bethe-Salpeter equations of any unrenormalizable field theory accessible to conventional perturbation theory. (D.C.W.)

16704 HOMOGENEOUS NONSTATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. B. K. Datta (Surendra Nath Coll., Calcutta). Nuovo Cimento (10), 36: 109-14(Mar. 1, 1965).

Two solutions of the Rainich equations for electromagnetic fields which are spatially homogeneous are presented. Except for some particular times when the field is entirely singular, there is a divergence-free electromagnetic field at all other times. (auth)

16705 DERIVATIVE COUPLING IN RELATIVISTIC QUANTUM FIELD THEORY. B. Klaiber (Universitat, Vienna). Nuovo Cimento (10), 36: 165-73(Mar. 1, 1965).

The exact solution of the vector derivative coupling between a spinor and a scalar field in 4 dimensions is discussed. The nontemperedness of the Wightman functions introduces a certain kind of nonlocality. Especially for zero mass of the scalar field, the 4-dimensional model is essentially different from the 2-dimensional one. (auth)

16706 NECESSARY CONDITION FOR THE EXISTENCE OF BOUND STATES. F. Calogero (Matscience, Inst. of Mathematical Sciences, Madras). Nuovo Cimento (10), 36: 199-201(Mar. 1, 1965).

It is proved that, for an attractive potential V(r) whose slope never changes sign, a necessary condition for the existence of bound states is that $\int_0^\infty dr|V(r)|^{\frac{1}{2}} > \pi/2$. (auth)

16707 SOME REMARKS ON THE RENORMALIZATION CONSTANTS AND THE BOUND-STATE CONDITION. G. Furlan and G. Mahoux (CERN, Geneva). Nuovo Cimento (10), 36: 215-35(Mar. 1, 1965).

Different examples of field theories, are considered super-renormalizable, renormalizable, and nonrenormalizable ones, in order to evaluate the renormalization constant Z of the vertex between a bound state and the component particles. In ladder approximation, some properties of the Z's are examined, with particular regard to the possibility of the cut-off factorization. (auth)

16708 GAUGE INVARIANCE AND QUANTUM MEASUREMENTS. K. Just (Univ. of Arizona, Tucson). Nuovo Cimento (10), 36: 294-5(Mar. 1, 1965).

The instruments for an objective registration of quantum events are discussed, and it is shown that a macroscopic device in the interior of a quantum experiment (never showing irreversible processes) must work electromagnetically. If the measuring device were to work nonelectromagnetically, the predicted result would depend on the gauge. (C.E.S.)

16709 FINITE MASS RENORMALIZATION IN FIELD THEORY. J. S. Dowker (Univ. of Manchester, Eng.). Nuovo Cimento (10), 36: 304(Mar. 1, 1965).

It is shown that it is possible to obtain a finite mass renormalization in field theory if the assumption that the unrenormalized Green's function has no zeros on the real axis is dropped. (C.E.S.)

16710 DECOMPOSITION OF THE SCHRÖDINGER EQUATION FOR TWO IDENTICAL PARTICLES AND A THIRD PARTICLE OF FINITE MASS. A. K. Bhatia and A. Temkin (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 137: A1335-43(Mar. 1, 1965).

An angular-momentum decomposition of the Schrödinger equation is extended to the case of two identical particles and a third particle of finite mass. The case of three unequal-mass particles is treated in an appendix. The decomposition is effected with the use of a symmetric choice of Euler angles, and the radial equations are given in two useful forms. The radial equations are shown to yield the Born-Oppenheimer equations for H_2^+ in the limit that the two identical particles approach infinite mass. Other aspects of this limit are discussed, and general rules which relate the total-angular-momentum states of the three-body system to the molecular states of H_2^+ are examined. (auth)

16711 RELATIVISTIC EQUATIONS FOR SPHERICAL GRAVITATIONAL COLLAPSE WITH ESCAPING NEUTRINOS. Charles W. Misner (Univ. of California, Livermore and Univ. of Maryland, College Park). Phys. Rev., 137: B1360-4(Mar. 8, 1965).

The general-relativity equations for the dynamics of a self-gravitating sphere of ideal fluid as given by Misner and Sharp are modified to allow an extremely simplified heat-transfer process in which internal energy is converted (at some rate controlled by an equation of state) into an outward flux of neutrinos which have no subsequent interaction with matter. This outward flux of radiation carries with it an inward non-Newtonian gravitational force field. Thus, if a portion Δm of some central mass is converted into escaping radiation, the corresponding energy increase $\sim G\Delta m/R$ of each unit mass of surrounding matter is seen to be the work done by this non-Newtonian inward impulse accompanying the radiation. (auth)

16712 VAIDYA'S RADIATING SCHWARZSCHILD METRIC. R. W. Lindquist (Univ. of California, Livermore), R. A. Schwartz, and C. W. Misner. Phys. Rev., 137: B1364-8(Mar. 8, 1965). (UCRL-12059-T)

In Vaidya's metric for a radiating sphere, $ds^2 = -(1 - 2mr^{-1})du^2 - 2dudr + r^2d\Omega^2$, where m(u) is a nonincreasing function of the retarded time u = t − r, it is verified that −dm/du is the total power output as given by the

Landau-Lifshitz stress-energy pseudotensor. It is related through red-shift and Doppler-shift factors to the apparent luminosity L for an observer moving radially in this gravitational field. It is argued that the hypersurface $r = 2m(u)$ can not be realized physically, but that a hypersurface $r = 2m(\infty)$ at $u = \infty$ (which is not adequately represented in presently available coordinate systems) shows the total red-shift characteristic of the Schwarzschile "singularity." The geodesic equations are written out to display a gravitational "induction field" $-GL/c^3r$ associated with a changing mass in the Newtonian $-Gm/r^2$ field. (auth)

16713 CLASSICAL ELECTRON IN GENERAL RELATIVITY. R. Penney (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 137: B1385-93(Mar. 8, 1965).

The usual field equations of general relativity are modified to provide for the existence of electrons. The resulting equations are considered to be microscopically true. The macroscopic averages of the equations are the usual Einstein field equations. On the basis of the field equations, it is shown that an electron may be constructed which is stable and has a momentum and energy which form a four-vector. The electron is held together by the gradient of the Gaussian curvature and is 75% electromagnetic and 25% gravitational energy. The radiation reaction problem is examined, and it is shown that the Cauchy problem for the field equations is nonregular in the sense that, as with the Lorentz-Dirac equation, one component of the initial acceleration of the electron must be specified. An interesting consequence of the field equations is that a purely electric (static) electron is not a regular solution. The future development of such a particle is not determined. Thus, a spherically symmetric electron must be dynamic in character (have currents and consequent magnetic moments). (auth)

16714 EXPECTATION-VALUE DISTRIBUTIONS. Nazakat Ullah (Tata Inst. of Fundamental Research, Bombay) and Charles E. Porter. Phys. Rev., 137: B1394-5 (Mar. 8, 1965).

A systematic procedure is described to derive the moment generating function for orthogonal, unitary, and symplectic ensembles. Expressions are given for the distribution of the expectation value. It is shown that for large dimensions the distribution is Gaussian. (auth)

16715 RENORMALIZED ACTION INTEGRALS IN CLASSICAL ELECTRODYNAMICS. Melvin Schwartz (Adelphi Univ., Garden City, N. Y.). Phys. Rev., 137: B1410-?(Mar. 8, 1965).

Bergmann and Rohrlich have presented classical action integrals in electrodynamics which lead to the renormalized relativistic Lorentz-Dirac equations for a point charge; the relation between the two approaches is examined. In neither case can the action integral be obtained by transformation from an unrenormalized form. For Bergmann's form, mass renormalization of the equations of motion and of the action integral for the unrenormalized equation are not commutable. Furthermore, Bergmann's integral automatically leads to second-class constraints among the canonical variables. The nonrelativisitic approximation to Bergmann's integral is compared with the renormalized form of the nonrelativistic approximation to the unrenormalized action integral which leads to the unrenormalized equations of motion. While Bergmann's integral involves a nonlocal separation of the total field, the latter integral is obtained through a local separation. It is pointed out that both forms lead to the same renormalized equations of motion, but lead to Hamiltonians which can not be related to each other by transformation. For both Bergmann's and Rohrlich's Hamiltonians, the insertion of solutions based on a Fourier decomposition of the free-field and associated free-field commutation rules leads to an interaction-picture type of formalism. (auth)

16716 DISSIPATION IN QUANTUM MECHANICS. TWO-LEVEL SYSTEM. PART III. I. R. Senitzky (Army Electronics Labs., Fort Monmouth, N. J.). Phys. Rev., 137: A1635-43(Mar. 15, 1965).

Previous theory describing the behavior of a general two-level system (TLS) coupled to a loss mechanism and driven by an oscillating field near resonance is generalized to include an arbitrary driving field. Integro-differential equations of motion for the expectation values of the Pauli spin matrices, which describe completely the behavior of a TLS, are derived. The relaxation constants involved in these equations prove to be frequency-dependent, and reactive effects produced by the loss mechanism appear. It is shown that for an approximately monochromatic driving field near resonance, the general equations of motion can be approximated by differential equations. In the case of a magnetic TLS, these differential equations reduce to the Bloch equations if reactive effects are neglected. An exact solution of the general equations of motion for the special, simple case of a magnetic TLS being driven by a transverse rotating field of arbitrary frequency is obtained, and deviation from a Lorentzian resonance shape, caused by the frequency dependence of the relaxation and reactive constants, is found to exist. (auth)

16717 RIGID FRAMES IN GENERAL RELATIVITY. R. H. Boyer (Univ. of Liverpool). Proc. Roy. Soc. (London), Ser. A, 283: 343-55(Jan. 19, 1965).

Properties of a congruence of time-like curves were investigated, by means of a projection technique due to Cattaneo. Born's requirement of vanishing spatial rate of strain ensured that the congruence defines a rigid frame. Einstein's field equations imposed further conditions, whose physical consequences were explored. Sufficient conditions are given for the extension of the Herglotz-Noether classification theorem to general relativity. The case was investigated in which the curves of the congruence are the orbits of a group of motions. Validity of the Herglotz-Noether theorem is shown to be associated with the existence of a certain type of motion. Some properties of two special cases of rigid frames, isometric and irrotational motions, were examined. (auth)

16718 THE SINGULARITY IN THE SCHWARZSCHILD SPACE-TIME. Elizabeth Hilton (Univ. of London, Englefield, Surrey, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 491-7(Jan. 26, 1965).

The singularity at $r = 1$ in the Schwarzschild space-time metric $ds^2 = (1 - 1/r)dt^2 - dr^2/(1 - 1/r) - r^2(d\theta^2 + \sin^2\theta d\phi^2)$ is investigated from a physical standpoint. Contrary to current opinion, it is shown that the surface $r = 1$ is an irremovable physical barrier. The logical status of the "removal" of the singularity is considered. (auth)

16719 TYPE OF von NEUMANN ALGEBRA ASSOCIATED WITH FREE FIELD. Huzihiro Araki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 956-65(Dec. 1964).

The type of von Neumann algebras associated with the quantum theory of a free Bose field is found. It is type III_∞, except the case of type I_∞ determined previously. (auth)

16720 COORDINATE CONDITIONS AND CANONICAL FORMALISMS IN GRAVITATIONAL THEORY. James L. Anderson (Stevens Inst. of Tech., Hoboken, N. J.). Rev. Mod. Phys., 36: 929-38(Oct. 1964).

The Dirac form of the general-relativistic Hamiltonian is considered. This form contains a metric element of the form $g_{0\mu}$, which renders the expression for the Hamiltonian incomplete. A review is presented of various methods used to remove the $g_{0\mu}$, the Hamiltonians that result therefrom, and the relations between these various methods. (T.F.H.)

16721 ANGULAR MOMENTUM WAVE FUNCTIONS CONSTRUCTED BY PROJECTOR OPERATORS. Per-olov Loewdin (Uppsala Univ. and Univ. of Florida, Gainesville). Rev. Mod. Phys., 36: 966-76(Oct. 1964).

An analytic method is presented for constructing wave functions of pure angular momentum for a composite system. The composite is considered as an entity to which the various component angular momenta contribute in an equivalent and not necessarily ordered way. Following a discussion of the general properties of angular momen-

tum, the argument is developed by investigating the definitions, expansion, and representation of the projection operator, and construction of the projection operator matrix. Examples are given for spin and angular momentum. (T.F.H.)

16722 TABLES OF CLEBSCH-GORDAN COEFFICIENTS OF SU_3. P. McNamee and Frank Chilton (Stanford Univ., Calif.). Rev. Mod. Phys., 36: 1005-24(Oct. 1964).

The Clebsch-Gordan coefficients of SU_3 are tabulated, with notes on their use. (T.F.H.)

16723 PARTICLES AND THE S-MATRIX IN QUANTUM FIELD THEORY. Yu. M. Shirokov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 222-31(Jan. 1965). (In Russian)

It is shown that the matrix element $\langle 2|A(x)|2\rangle$ of a scalar neutral field A(x) taken between two-particle states in the in-basis processes poles which are not of a one-particle character. The residues in the poles calculated in an explicit form are expressed in terms of the scattering amplitude. Only the general axioms of quantum field theory are employed in the deduction. Similar poles also exist in a number of other matrix elements. Poles of this type are used for solving the following problem: for a scalar neutral field A(x), is given by matrix elements $\langle\alpha|A(x)|\alpha'\rangle$ in an arbitrary basis a method is found for obtaining the particle mass spectrum, a set of quantities $\langle\alpha|0\rangle$, $\langle\alpha|\varkappa_1 k_1\rangle$, $\langle\alpha|\varkappa_1\varkappa_2 k_1 k_2\rangle$, ... comprising the matrix for transition from the initial basis to the in-basis, and the S-matrix. The method can be extended to the case of particles with spins and also to local quantities of any physical nature or tensor dimension. The vacuum state is not assumed to be cyclic with respect to the field. (auth)

16724 SPIN OF VIRTUAL GRAVITONS. V. I. Zakharov (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 303-9(Jan. 1965). (In Russian)

The problem of the spin of an interacting gravitational field is considered within the framework of linearized gravitational theory. It is shown that virtual gravitons may carry an angular momentum of 2 or 0. Due to transversality of the gravitational vertex only gravitons of spin 2 with a spirality of ±2 are emitted. It is shown that gauge invariance plays the role of an auxiliary condition in gravidynamics; thus, only gauge-invariant fields interact with matter. The result is extended to the case of higher spin fields of zero mass. (auth)

16725 A TWO-COMPONENT QUANTUM ELECTRODYNAMIC FORMULATION. I. Byalynitski-Birulya. p.132-50 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The basic properties of electrodynamics are discussed for the case of an external magnetic field, starting with the Dirac equations. The basis of spinor calculus is reviewed, including the effects of a Lorentz transformation. Here spinor space is defined as a linear space of complex two-dimensional vectors. By using either the S or $(S^+)^{-1}$ matrix in the Lorentz transformation, two types of spinors are obtained. The Dirac equations are studied from the point of view of spinor calculus. The two-component spinor calculus is applied to the problem of the quantum electric field. In the usual formulation of quantum electrodynamics, there arise 8 operators. In the two-component formulation there are only 4 operators, but the equations are good to second order. The quantum electromagnetic field is also studied; the Lagrangian for the field is nonhermitian. The equations are applied to the structure of the electron propagator. It is shown that the S matrices in the two-component formulation are equivalent to those of the usual formulation. The equations for the electron propagator which arise from the two-component formulation are significantly different from those obtained to first order from the usual formulation by means of perturbation theory. (TTT)

16726 LOBACHEVSKII GEOMETRY AND THEORY OF RELATIVITY. N. A. Chernikov. p.151-78 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom III." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The solution to the many-body problem for the case of relativistic velocities may easily be carried out using velocity space in Lobachevsky geometry, where the curvature of the velocity space $K = -1/c^2$. The characteristics of the general velocity space are described. Discussion is limited to the case of affine spatial coordinates. The motion of a particle can be treated in a space-time coordinate system in which its motion is nonrelativistic (non-relativistic coordinates) with transformation of the results to another coordinate system. In the nonrelativistic coordinates Newton's law F = ma may be applied, where m is the rest mass of the particle. Examples are given for the case in which F is independent of position and for motion in an external electromagnetic field. Many-particle scattering is treated as the coagulation of the incident particles into one particle which immediately decays into other particles. In Euclidian velocity space there are two kinds of relations where the vectors pass through one point corresponding to positive rest masses, and where the vectors are parallel, corresponding to zero rest mass (photon, neutrino). In Lobachevsky velocity space there is also a case in which the vectors are orthogonal to a given surface, corresponding to imaginary rest masses. The meaning of the imaginary rest masses is discussed. Thirty test problems are included. (TTT)

16727 SELF-CONSISTENT VARIATION–PERTURBATION METHOD. A. Mukherji (Saha Inst. of Nuclear Physics, Calcutta). p.507-11 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Self-consistent-field wave functions, Ψ, of atoms and ions are considered. A perturbing hamiltonian, H_1, produces a change $\int\Psi_i$ on the ith orbital. A formalism is described in which the effect of the changes $\int\Psi_i$ on themselves is taken into consideration, thus accounting for the contribution to the effective hamiltonian due to changes in the charge distributions of the electrons, which are often of the order of H_1. The formalism results in obtaining self-consistent perturbed orbitals. (M.J.T.)

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Refer also to abstracts 15832, 16420, 17104, and 17147.

16728 (AD-603599) TIME BEHAVIOR OF CHARGED PARTICLES INJECTED BY 1962 HIGH-ALTITUDE RUSSIAN NUCLEAR TESTS (thesis). George Albert Kuck (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Aug. 1964. 101p. (GSP-64). $4.00(CFSTI).

The time behavior of the concentration of charged particles injected by the 1962 high altitude Russian nuclear test series was followed by the instruments on Air Force satellite 1962 BK. Two wide angle radiation detectors were able to follow the time decay of the charged particles for 45 days after the explosions. The data for this time period were analyzed and presented as pitch angle distributions and maximum counting rates of the detectors in the L shell regions of space at different magnetic latitudes. The decay rate of the injected charged particles in these L shells was consistent with an exponential decay having a "half life" between 9 and 18 days. (auth)

16729 EXCITATION OF CYCLOTRON SPIKES IN THE IONOSPHERIC PLASMA. G. E. K. Lockwood (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 43: 291-7(Feb. 1965).

The occurrence of resonances in the ionosphere at frequencies which are harmonics of the gyrofrequency was detected by the topside-sounder satellite, Alouette I. It

was observed that the occurrence of cyclotron spikes on ionograms is a function of the angle between the antenna and the earth's magnetic field. The number of cyclotron spikes observed is a maximum when the appropriate antenna is parallel to the earth's magnetic field. (auth)

16730 THE DRIFT VELOCITY OF TRAPPED PARTICLES. A. Hassitt (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 70: 535-40(Feb. 1, 1965).

The longitudinal drift velocity of a particle trapped in the earth's field is considered. It is shown that there is a relation between drift velocities at different points on any line of force and that the drift velocities of particles with different mirror points are also related. These relations can be used to simplify the calculation of the average effects of the atmosphere. (auth)

16731 DAYTIME TRAPPED ELECTRON INTENSITIES AT HIGH LATITUDES AT 1100 KILOMETERS. D. J. Williams and A. M. Smith (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 541-56(Feb. 1, 1965).

Data from the polar orbiting satellite 1963 38C were used to study the behavior of day-side intensities of trapped electrons in the energy ranges $E_e \geq 280$ kev and ≥1.2 Mev during the period October 1 through November 1, 1963. During this time the satellite orbital plane was within 30° of the earth-sun line. The data show that at $L = 2$ there is no apparent correlation of charged-particle intensities with magnetic activity, at $L = 2.5$ and 3 the trapped electrons are effected only by intense magnetic activity, in the range $3.5 \lesssim L \lesssim 6$ the trapped intensities follow the general trend of the magnetic activity including the 27-day recurring increase in the level of magnetic activity, and above $L \sim 6$ the trapped electrons become much more sensitive to the detailed fluctuations in the magnetic activity indices. Quiet-time data show a steady decay in trapped intensities for $L \geq 3$. Time delays in the particle response to magnetic variations are found to increase with both increasing energy and L value. A rough correlation of the energy spectrum with magnetic activity is obtained. (auth)

16732 DISTORTIONS IN THE RADIATION CAVITY AS MEASURED BY AN 1100-KILOMETER POLAR ORBITING SATELLITE. J. J. Williams and W. F. Palmer (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 557-67(Feb. 1, 1965).

Data from the polar orbiting satellite 1963 38C were used to study distortions in the radiation cavity and their relation to a model of the distorted magnetosphere. The study was concerned with trapped electrons of energy ≥280 kev during the period October 2 to November 5, 1963. Diurnal effects in the trapped electron intensities are obtained for periods of slight, moderate, and intense magnetic activity, taking into account the varying dipole orientation. Consistency of the data with adiabatic invariant and energy conservation in a distorted field is suggested. (auth)

16733 LONGITUDINAL VARIATIONS OF HIGH ENERGY ELECTRONS AT LOW ALTITUDES. W. L. Imhof and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 569-77(Feb. 1, 1965).

Measurements were made, from low altitude polar orbiting satellites, of the longitudinal variations of electrons observed on low L shells, $L \leq 1.7$. Data were taken in late 1962 with shielded plastic scintillators having effective electron threshold energies of 1.2, 2.4, and 5.0 Mev, and in late 1963 with a plastic scintillation spectrometer equipped with a 16-channel pulse height analyzer operating in two energy ranges (0.3 to 2.6 Mev, and 0.3 to 10.0 Mev) and coded in binary form for the digitized telemetry of individual counts. In the energy interval 0.28–0.71 Mev, the fluxes just west of the Brazilian magnetic anomaly, for B and L coordinates which reach below 100 km, are about an order of magnitude greater than those measured just east of the anomaly at comparable values of B and L. For h_{min} in the range 0 to 200 km, the energy spectrum of electrons on L shells in the interval 1.2–1.4 is found to soften rapidly with increasing B value. The flux and energy spectrum suggests that many of the electrons observed at B, L points with $h_{min} < 0$ km for $L \approx 1.2–1.4$ originate from the trapped radiation belt and that an important redistribution process may be single large-angle Coulomb scatterings in the atmosphere. (auth)

16734 AURORAL PARALLACTIC MEASUREMENTS AT BYRD STATION, ANTARCTICA, DURING 1963. J. H. Kinsey (Arctic Inst. of North America, Washington, D. C.). J. Geophys. Res., 70: 579-86(Feb. 1, 1965).

The results of the analysis of 96 parallactic, photographic pairs of the aurora taken over Byrd Station, Antarctica, during the austral winter of 1963 are presented. The average height of the lower borders of all auroral forms was found to be 106.7 km, and the average heights of homogeneous and rayed forms were 107.5 and 105.9 km, respectively. Relative intensity measurements taken simultaneously with the photographs show that the heights decreased with increasing intensity for all auroral forms. From plots of the projections on the surface of the same auroral form in successive photographs, velocities of the forms perpendicular to their contour were found of the order of 100 m/s. The alignment of the contours was generally northwest to southeast. (auth)

16735 THE EFFECT OF A VARIABLE ELECTRON TEMPERATURE ON THE EQUATORIAL ELECTRON DENSITY DISTRIBUTION IN THE UPPER IONOSPHERE. Richard A. Goldberg (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 70: 655-65(Feb. 1, 1965).

By incorporating a model for the measured electron temperature distribution at the magnetic equator into the isothermal and temperature equilibrium theory of Goldberg, Kendall, and Schmerling, it was possible to gain further insight into the behavior of the equatorial geomagnetic anomaly under steady-state and equinoctial conditions. In particular, it is shown that the measured deviation from thermal equilibrium in the bottomside ionosphere is very influential in allowing extension of the previous theoretical description of the geomagnetic anomaly well into the bottomside ionosphere and to higher latitudes than originally applicable. For completeness the effect of gravitational variation is included, but it is shown that this effect alone contributes only minor improvements to the original results. Finally, several less common properties in the behavior of the geomagnetic anomaly are investigated, and it is shown under what conditions these secondary effects occur. (auth)

16736 THE LATITUDE VARIATION OF APPARENT HORIZONTAL MOVEMENTS IN THE E REGION OF THE IONOSPHERE. G. L. Narayana Rao and B. Ramachandra Rao (Andhra Univ., Waltair, India). J. Geophys. Res., 70: 667-77(Feb. 1, 1965).

Results are given of a detailed study of the horizontal drifts in the ionosphere recorded at selected northern and southern hemisphere stations. Certain important general conclusions about the differences in the behavior of drifts at the northern and southern hemisphere stations and the variation of the drift parameters with latitude are presented. (auth)

16737 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln (ed.). (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 715-17(Feb. 1, 1965).

A table is given of principal magnetic storms from July to December, 1964, including data on storm time, sudden commencement, degree of activity, maximal activity, and ranges. Selected geomagnetic and solar data are presented for days in September, 1964, giving K_p, C_1, C_p, A_p, K_{Fr}, and R_z. (M.J.T.)

16738 ANOMALOUS HIGH-FREQUENCY PROPAGATION AFTER THE SOVIET NUCLEAR TEST OF OCTOBER 30, 1961. Robert D. Sears (Illinois Inst. of Tech., Chicago). J. Geophys. Res., 70: 728-30(Feb. 1, 1965).

Signal levels of radar at Thule, Greenland, are reported for the anomalous propagation after the Soviet test at

Novaya Zemlya, for frequencies of 12, 18, and 30 Mc. Mechanisms postulated to explain the signal-path enhancements for both on- and off-great circle paths are the release of ionizing radiation by the fireball rising into the stratosphere and the transmission of the atmospheric shock into the ionosphere as a density wave. (M.J.T.)

16739 THE SPECTRUM OF THE POLAR AURORAS. I. IDENTIFICATIONS OF THE ATOMIC EMISSIONS. C. Arpigny (Universite, Liege). Mem. Soc. Roy. Sci. Liege, 2: 1-30(1960). (In French)

A critical study was made of auroral identifications proposed previously, and data relative to these identifications are presented. A table of relative intensities of multiplets for transitions involving NI, NII, OI, and OII is presented. The wavelengths of these emissions and their intensities are compared with those recorded for the auroral spectra; tables are given for the systems NI, NII, OI, OII, and forbidden transitions. (BBB)

16740 THE SPECTRUM OF THE POLAR AURORAS. II. MOLECULAR IDENTIFICATIONS. L. Remy-Battiau (Universite, Liege). Mem. Soc. Roy. Sci. Liege, 2: 31-78 (1960). (In French)

Wavelength and intensity of auroral spectra and molecular systems were compared. Synthetic spectra were constructed for several bands of the systems N_2, N_2^+, O_2^+, and OH; effects of slit width, rotation temperature, and resolving power on observed spectra were determined. Synthetic spectra and tables are given for the systems considered: first positive system of N_2 ($B^3\pi_g \rightarrow A^3\Sigma_u^+$); second positive system of N_2 ($C^3\pi_u \rightarrow B^3\pi_g$); Vegard-Kaplan system of N_2 ($A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$); Goldstein-Kaplan system of N_2 ($C' \rightarrow B^3\pi_g$); Green system of N_2; first negative system of N_2^+ ($B^2\Sigma_u^+ \rightarrow X^2\Sigma_g^+$); Meinel system of N_2^+ ($A^2\pi \rightarrow X^2\Sigma$); atmospheric system of O_2 ($b^1\Sigma_g^+ \rightarrow X^3\Sigma_g^-$); Green and Schumann-Runge systems of O_2; first negative system of O_2^+ ($b^4\Sigma_g^- \rightarrow a^4\pi_u$); second negative system of O_2^+ ($A^2\pi_u \rightarrow X^2\pi_g$); β system of NO; three systems of NH; systems of CH, CO, CO^+, and CN; and the $A^2\Sigma^+ \rightarrow X^2\pi$ system of OH. (BBB)

16741 INFLUENCE OF SOLAR FLARE PARTICLES ON THE GENERAL CIRCULATION OF THE ATMOSPHERE. C. J. E. Schuurmans (Royal Netherlands Meteorological Inst., De Bilt). Nature, 205: 167-8(Jan. 9, 1965).

The change in height of the 500-mb level is computed for the first 24 hr after a flare, for 54 grid points covering a large portion of the Northern hemisphere. A theoretical computation was performed for the pressure variations in the atmosphere due to a particle-induced heat source having the shape of the auroral zone; the main features of the experimental results are explained by this model. The study is extended to other levels than 500 mb, while the duration of the influence is examined. (M.J.T.)

16742 A MEASUREMENT OF POSITIVE ION DENSITY IN THE NIGHT-TIME F-REGION. K. Norman and A. P. Willmore (University Coll., London). Planetary Space Sci., 13: 1-8(Jan. 1965).

The time variation of positive ion current with respect to an array of four plane probes was used to deduce the attitude behavior of the sounding rocket relative to its velocity vector. The attitude information was then used to determine the ambient positive ion density in the height range 200-500 km and to determine the current relative to a probe in the wake of the rocket. (auth)

16743 CONFIGURATION OF AURORAL RADIATION IN SPACE. A. J. Dessler and R. D. Juday (Rice Univ., Houston, Tex.). Planetary Space Sci., 13: 63-72(Jan. 1965).

The spatial configuration of the energetic particles that cause the aurora is described, based on an open tail model of the magnetosphere. The magnetic flux originating poleward of the auroral zones fills the open tail, which stretches out away from the earth in the anti-sun direction. It is expected that auroral radiation extends down the length of the magnetospheric tail for at least 10^2 earth radii. Relatively near the earth (~20-60 R_E) the radiation should form a pattern rather like a Greek theta (θ) in cross section with the center line of the theta, on the average, in the ecliptic plane and the circular portion having a diameter about 40-70 R_E. Farther away from the earth (beyond about $10^2 R_E$) the radiation pattern should change into two cylinders with a figure 8 cross section. In arriving at this description, it was postulated that the auroral radiation is energized at the magnetopause along the extended tail for a distance of more than 10^2 earth radii where the solar and magnetospheric plasmas are in relative motion. This postulate enables auroral zones to be defined and both daytime and nighttime auroral particle precipitation to be explained. (auth)

16744 PRELIMINARY EXPERIMENTS FOR THE STUDY OF THE INTERPLANETARY MEDIUM BY THE RELEASE OF METAL VAPOR IN THE UPPER ATMOSPHERE. H. Foeppl, G. Haerendel, J. Loidl, R. Luest, F. Melzner, B. Meyer, H. Neuss, and E. Rieger (Max-Planck-Institut für Physik und Astrophysik, Garching, Ger.). Planetary Space Sci., 13: 95-114(Feb. 1965).

It has been proposed to create an artificial ion cloud in interplanetary space for studying the state of the interplanetary medium. Data concerning excitation and ionization by sunlight are given for the alkali earth metals Ca, Sr, Ba and for the rare earth Eu which could be used for such an ion cloud. The expansion of the artificial cloud in interplanetary space, the interaction of the ion cloud with the interplanetary medium and the minimum masses required are estimated. The methods used for the vaporization of the metals are discussed. Different chemical reactions which might have occurred are summarized. Seven different experiments were carried out with sounding rockets in the Sahara and in Sardinia. In these experiments metal vapor was released in the upper atmosphere. The results of the sounding rocket experiments of May 1963 are discussed since the data for the later experiments are not yet reduced. The main results for the physical properties of the observed clouds and of the upper atmosphere at a height of about 125 km are: the initial radius of the cloud was 0.25 km; the velocity of the wind changed during the period of observation (15 min) from 55 to 90 $msec^{-1}$; a wind shear of about 1 $msec^{-1}$/km apparently exists there; the diameter of the cloud increased faster than would be expected from purely molecular diffusion; the neutral Sr cloud changed from the optically thick to the optically thin case; about 4% of the Sr which was present only as impurity came out in the form of free atoms, as compared with 0.01% of the Ba; the released material is removed by reactions with the atmosphere in a time scale of the order of 10^3 sec. In the experiments carried out in February 1964, the Al used in the chemical reactions had been replaced by Mg. This led to the production of Sr clouds which were optically thick during the entire period of observation and about 30% or more Sr came out in the form of free atoms. (auth)

16745 STABILITY OF THE MAGNETOSPHERIC BOUNDARY. Amiya K. Sen (Columbia Univ., New York). Planetary Space Sci., 13: 131-41(Feb. 1965).

The magnetospheric boundary which is the interface between solar wind and the magnetosphere is viewed as a surface of hydromagnetic Kelvin-Helmholtz discontinuity. The crucial effect of compressibility on its stability is discussed. It is shown that substantial portions of the dayside of the boundary are unstable under all conditions of solar wind. The spatial extent of the instability on the dayside is almost completely independent of the speed and density of solar wind. But it is critically dependent on the angle between the geomagnetic field and the compressed interplanetary field at the boundary. The stability of the nightside of the boundary is dependent on solar wind speed among other factors; the higher the speed, the more extensive is the stable region. (auth)

16746 IONOSPHERIC ELECTRON TEMPERATURES NEAR DAWN. A. Dalgarno (Queen's Univ., Belfast) and M. B. McElroy. Planetary Space Sci., 13: 143-5(Feb. 1965).

Some calculations of electron heating in the ionosphere near dawn are summarized. (D.C.W.)

16747 RESEARCH IN GEOPHYSICS. VOLUME 2. SOLID EARTH AND INTERFACE PHENOMENA. Hugh Odishaw, ed. Cambridge, Mass., Massachusetts Institute of Technology, 1964. 613p. $12.50.

Twenty-two articles are included. A separate abstract was prepared for one. Articles not abstracted are on seismology, longitude and latitude, earth tides, gravity, oceanography, meteorology and the ice cover in Antarctica, atmospheric circulation, and the earth's heat balance and uppermantle. (M.J.T.)

For an abstract of the individual chapter see: 16247.

16748 RESEARCH IN GEOPHYSICS. VOLUME 1. SUN, UPPER ATMOSPHERE, AND SPACE. Hugh Odishaw, ed. Cambridge, Mass., Massachusetts Institute of Technology, 1964. 593. $12.50.

Twenty-one articles are included. Separate abstracts were prepared for 18. Two articles were previously abstracted for NSA; see abstracts 17: 34696 and 18: 44662. (M.J.T.)

For abstracts of individual chapters see: 16362, 16363, 16364, 16434, 16435, 16749, 16750, 16751, 16752, 16753, 16754, 16755, 16756, 16757, 16758, 16759, 16760, and 16761.

16749 A SURVEY OF MAGNETOSPHERIC BOUNDARY PHENOMENA. L. A. Frank and J. A. Van Allen (State Univ. of Iowa, Iowa City). p.161-87 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Present knowledge of the region of interaction of the earth's magnetic field and the solar wind near the boundary of the magnetosphere is summarized. Trajectories of several space probes and earth satellites are compared. Data on the fluxes of low- and high-energy charged particles near the magnetospheric boundary are summarized. The association of low-altitude, high-latitude phenomena with processes occurring at large radial distances in the geomagnetic equatorial plane via geomagnetic lines of force is mentioned. Results of surveys of the gross character of magnetic fields near the magnetospheric boundary are recapitulated. The possibility of a significant role of polarization electric fields in charged-particle dynamics is discussed. Results of computation of shocks, deformation, and motion of the magnetospheric boundary are displayed. Studies on the asymmetry of dawn-evening distribution of energetic electrons are reviewed. 58 references. (M.J.T.)

16750 THE GEOCORONA. Joseph W. Chamberlain (Kitt Peak National Observatory, Tucson, Ariz.). p.189-96 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Observations of the uv (Lyman α) radiation in the night sky, which indicate the presence of the hydrogen geocorona, are reviewed. Early arguments of interplanetary vs terrestrial location of the emitting H are summarized. Possible models for the H distribution in space are mentioned. Theoretical work having a bearing on aspects of planetary coronas is briefly listed. The relation between planetary-corona and atmospheric-physics studies is indicated. (M.J.T.)

16751 IONOSPHERIC CONSTITUTION AND SOLAR CONTROL. Herbert Friedman (Naval Research Lab., Washington, D. C.). p.197-241 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

The major features of ionospheric behavior under the influence of solar electromagnetic radiation are reviewed. An accurate theory of ionospheric behavior cannot be formulated because of uncertainties in present knowledge of solar radiation intensity, atmosphere structure, radiation cross sections, ionic reaction rates, and electron loss processes. Published models and available data are used to construct a qualitative picture of production, composition, and behavior of the ionospheric D, E, and F regions. The question of the relative importance of energetic particles and electromagnetic radiation in the ionization and heating of the upper atmosphere is briefly reviewed. The effects of solar flares and associated x-ray emission on sudden ionospheric disturbances are considered. 87 references. (M.J.T.)

16752 THE STRUCTURE OF THE UPPER ATMOSPHERE. M. Nicolet (National Center for Space Research, Brussels). p.243-75 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Division of the atmosphere into regions on the basis of temperature gradient troposphere, stratosphere, mesosphere, and thermosphere — and on the basis of composition — homosphere and heterosphere — is explained. Chemical reactions in the atmosphere are discussed. The density of the heterosphere is considered. The variation of atmospheric temperature with solar activity is reviewed. Vertical diffusion in the heterosphere is discussed. Diffusion, thermobalance, and composition of the heterosphere are discussed. The exosphere problem and the region of inapplicability of the hydrostatic approximation are mentioned. 52 references. (M.J.T.)

16753 STUDIES OF IONOSPHERIC ABSORPTION. W. R. Piggott (Dept. of Scientific and Industrial Research, Sough, Bucks, Eng.). p.277-97 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

A few typical results of ionospheric absorption measurements obtained in the IGY are mentioned. Theories used to interpret the data and methods of estimating whether absorption is mainly in or below the E layer are discussed. Results of preliminary tests of these methods are given. Studies on diurnal variation of absorption at high latitudes are surveyed. 72 references. (M.J.T.)

16754 IONOSPHERIC MOVEMENTS AND IRREGULARITIES. Colin O. Hines (Univ. of Chicago). p.299-318 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Results of IGY and other surveys are used for considering the movement of equatorial and auroral sporadic-E ionization irregularities, the formation of field-aligned F-region irregularities at low and high latitudes, E-region winds, ionization drifts, magnetoshear sporadic E, traveling ionospheric disturbances, midlatitude spread F, atmospheric gravity waves, and turbulence in the low E region. 64 references. (M.J.T.)

16755 WHISTLERS AND VLF EMISSIONS. R. A. Helliwell (Stanford Univ., Calif.). p.319-33 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

The present status of research on whistlers and vlf emissions is reviewed. Their production and structure are discussed. Results from the IGY-IGC period, defining the gross features of whistler distribution and classifying vlf emissions, are surveyed. The use of these phenomena to study electron density in the magnetosphere is mentioned. Some post-IGY results are summarized, and problems remaining to be solved are discussed. (M.J.T.)

16756 THE AURORA. Sydney Chapman (Univ. of Alaska, College and High Altitude Observatory, Boulder, Colo.) and Syun-Ichi Akasofu. p.367-400 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Auroral research before and during the IGY is summarized. The morphology, cycles, and distribution of auroras are described. Differences between the auroral-zone and polar-cap auroras are mentioned. Studies in auroral spectroscopy are reviewed. The relation between auroral particles and the radiation belts is discussed. Radio techniques used for auroral studies are considered. 136 references. (M.J.T.)

16757 AIRGLOW. D. Barbier (Paris Observatory and Astrophysical Inst. of Paris). p.401-22 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Problems in correlating data from different stations during the IGY are surveyed. Some results obtained during the IGY are reviewed. The discovery of new spectral lines in the airglow is cited. Attempts to determine the altitude of an airglow emitting layer and the correlations between radiations are discussed. Studies on interferometric and spectroscopic temperature determination are surveyed. Results of work on the structure of the upper night layer, the nocturnal layer at 100 km, and the twilight and diurnal sodium emission are described. Some results on detection of lower latitude auroras are mentioned. 90 references. (M.J.T.)

16758 MAGNETIC FIELD AT THE POLES. Takesi Nagata (Tokyo Univ. and Univ. of Pittsburgh). p.423-53 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Results from IGY measurements of geomagnetic fields in the Arctic and Antarctic polar regions are reviewed. Discussions are presented of the secular variation during and after the IGY, the morphology of daily variations on quiet days, the conjugate relation of geomagnetic bay disturbances, and the conjugacy of large-amplitude pulsative variations. The relation between the polar geomagnetic field and the magnetosphere is discussed. 49 references. (M.J.T.)

16759 GEOMAGNETIC STORMS AND RELATED PHENOMENA. S. Matsushita (Univ. of Colorado, Boulder). p.455-83 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Observations of geomagnetic effects of solar phenomena, morphology of sudden commencements and sudden impulses, the disturbance-daily variation and storm-time variation, and geomagnetic effects of high-altitude nuclear explosions are discussed. Various models proposed for geomagnetic storms, using the ideas of the overhead current system, solar wind, magnetosphere, and plasma theories, are reviewed. 123 references. (M.J.T.)

16760 RAPID VARIATIONS OF THE ELECTROMAGNETIC FIELD OF THE EARTH. V. A. Troitskaya (Inst. of Physics of the Earth, Moscow). p.485-532 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Results of studies on continuous pulsations, pulsation trains, and application of rapid variations for the solution of geological problems are reviewed. Research on pearl-type pulsations, rapid irregular pulsations, and fine structure of magnetic storms is surveyed. Problems still to be considered are outlined. 115 references. (M.J.T.)

16761 THE INTERNATIONAL YEARS OF THE QUIET SUN 1964-1965. W. J. G. Beynon (University College of Wales, Aberystwyth, U. K.). p.541-53 of "Research in Geophysics. Vol. I." Cambridge, Mass., Massachusetts Institute of Technology, 1964.

Reasons for organizing the International Years of the Quiet Sun for the period Jan. 1, 1964, to Dec. 31, 1965, are discussed. Research planned in the areas of meteorology, geomagnetism, auroras, the airglow, the ionosphere, solar activity, and cosmic rays is outlined. A survey of the program for aeronomical investigations is given. The establishment of world data centers, world days, and the IQSY committee is summarized. (M.J.T.)

16762 THE MAGNETOSPHERE AND ITS BOUNDARY LAYER. Norman F. Ness (Goddard Space Flight Center, Greenbelt, Md.). 35p. (CONF-720-11)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Measurements of the solar wind and of the magnetic field surrounding the earth were made by the Interplanetary Monitoring Platform IMP-1 satellite. The distortion of the earth's magnetic field and the resultant boundary layer between the magnetosphere and the interplanetary medium are discussed. (D.L.C.)

16763 THE GEOMAGNETICALLY TRAPPED RADIATION. J. W. Freeman, Jr. (Rice Univ., Houston, Tex.). 29p. (CONF-720-9)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The closed, relatively stable magnetic lines of force in the magnetosphere of the earth are capable of trapping charged particles. The coordinate system for description of the Van Allen radiation is considered briefly. Detailed descriptions are given of the distributions of trapped protons and electrons. (D.L.C.)

Low Temperature Physics

Refer also to abstracts 15527, 15974, 16180, and 16854.

16764 (AROD-3473:2) SUPERCONDUCTIVITY IN SINGLE CRYSTALS OF COLUMBIUM AND COLUMBIUM-ZIRCONIUM ALLOYS. Final Report. C. S. Tedmon, Jr., L. C. Skinner, II, R. M. Rose, and J. Wulff (Massachusetts Inst. of Tech., Cambridge. Metals Processing Lab.). Nov. 30, 1964. Contract DA-ARO(D)-31-124-G478. 106p.

A discussion of hard superconductivity and the various filamentary models is presented with consideration of the sensitivity of niobium to cold-work, impurities, and substructure. Niobium single crystals, with axial orientations of ⟨100⟩, ⟨110⟩, ⟨111⟩, and ⟨112⟩ were grown in high vacuum. Transverse-field critical currents were measured with the currents and fields aligned with principal crystallographic axes. A large, reproducible anisotropy was found when the current flowed down the ⟨100⟩ axis with regard to the direction of the transverse field. The ⟨111⟩ axis showed little or no anisotropy in this connection. The Mendelssohn hard-mesh filamentary model is found to be inapplicable to the data. However, the results can be qualitatively accounted for by the flux structure predicted by Abrikosov and Goodman. The influences, dislocations and dislocation substructure are cited and corroborative evidence presented. (auth)

16765 CONCERNING ONE MODEL IN THE THEORY OF SUPER-CONDUCTIVITY. E. E. Tareeva (Steklov Mathematics Inst., Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 314-16(Nov. 11, 1964). (In Russian)

An attempt is made to obtain a generalization of the Bardeen-Cooper-Schrieffer model which would lead to an isotropic spectrum, since it is difficult to visualize that a system with relatively low density such as ^{3}He would have an anisotropic super-fluid phase, as follows from earlier results. A model is considered in which the pair responsible for the superconductivity, in contrast to the Cooper pair, is made up of electrons with momenta having absolute equal magnitudes but arbitrary directions. The problem is analyzed with the aid of two-time temperature Green's functions, and a solution is obtained satisfying the first four equations of motion for the Green's functions accurate to $V^{-\frac{1}{2}}$. An equation is obtained for the energy gap, compatible with the assumed model. (ATD)

16766 THERMAL PHASE TRANSITIONS IN SUPERCONDUCTING Nb–Zr ALLOYS. Clayton N. Whetstone and Charles E. Roos (Vanderbilt Univ., Nashville). J. Appl. Phys., 36: 783-91(Mar. 1965).

Experimental data are presented for the thermal propagation of a normal-superconducting boundary along wires of Nb–25%Zr, Nb–37%Zr, and Nb–51%Zr. The thermal propagation velocity was measured as a function of current at 4.2°K in constant longitudinal and transverse magnetic fields up to the upper critical field H_{c2} as well as in a zero magnetic field for temperatures between 2.5 and 11°K. Previous models which describe thermal propagation phenomena neglected the temperature dependences of the specific heat, thermal conductivity, and electrical resistivity. A more exact model is proposed which takes into account the temperature dependences of these quantities; all the present experimental data are in good agreement with this model. From a measurement at 4.2°K of the dependence of the thermal velocity on magnetic field, the high-field transition temperatures as a function of magnetic field are calculated for temperatures above 4.2°K. In con-

junction with the theory, the linear dependence of the thermal velocity on current implies a weak current dependence for both the transition temperature and superconducting-state specific heat in Nb–Zr alloys up to 3×10^5 A/cm^2. A method is discussed for using thermal propagation techniques to determine the superconducting-state specific heat in the presence of known transport currents and magnetic fields. (auth)

16767 RESISTIVE MEASUREMENTS OF STRUCTURAL EFFECTS IN SUPERCONDUCTING NIOBIUM. C. S. Tedmon, Jr., R. M. Rose, and J. Wulff (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 829-35(Mar. 1965).

Resistive measurements of the critical current density J_c in transverse magnetic fields were made on single crystals of niobium, which had been subjected to systematic thermal, mechanical, and chemical treatments in order to produce a wide range of substructural densities, and variations in the oxygen content. The introduction of plastic deformation into niobium crystals produced a peak in J_c at applied magnetic fields of strength H_{c2}, the upper critical field. The peaks in J_c were removed by annealing the crystals in the recovery range. The critical current density was increased both below and above H_{c2} by producing a dislocation substructure in the crystals. Small additions of oxygen also caused J_c to increase above and below H_{c2}. The upper critical field, however, was relatively insensitive to structure, varying only through the structure sensitivity of the bulk GLAG parameters. (auth)

16768 SUPERCONDUCTING CHARACTERISTICS OF THE HIGH-PRESSURE InSb–BETA TIN SYSTEM. M. D. Banus, Susan Nye Vernon, and H. C. Gatos (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 864(Mar. 1965).

The superconducting transition temperature in Sb-In-beta Sn alloys was measured as a function of tin content, using samples quenched directly from the melt and samples heat treated at 37 kbar after melting and prior to quenching. The results indicate that the Sb–In–beta Sn alloy does not exhibit a two-phase region, but rather complete solid solubility under equilibrium conditions. (D.C.W.)

16769 MOLECULAR EXCITATIONS IN LIQUID HELIUM. Lyle B. Borst (State Univ. of New York, Buffalo). Nature, 204: 870-1(Nov. 28, 1964).

The nature of the excitations in liquid helium that account for the normal component is investigated. Expressions are obtained for the eigenvalues of the wave function of the system in n dimensions, the partition function, the energy, and the internal energy. The heat capacity, the normal component, and the density for the theory are compared with the Landan theory and experiment. It is concluded that the character of the excitations of which the normal component is composed is quantitatively described by the normal coordinate representation of Born if restricted to rotationally excited atomic pairs. The superfluid (more accurately the Debye liquid) is a substrate within which the excitations exist as a distinguishable component. (C.E.S.)

16770 CRITICAL CONDITIONS FOR SECOND-ORDER TRANSITIONS IN SUPERCONDUCTING CYLINDERS. C. Dalmasso and E. Pagiola (Laboratorio di Ricerche Elettroniche Olivetti, Milan). Nuovo Cimento (10), 35: 811-22 (Feb. 1, 1965).

The Ginzburg-Landau equations are solved exactly in the linearized version for cylindrical samples, in a field applied parallel to the axis, to give critical conditions (field, temperature) in the assumption of second-order phase transition and fluxoid quantization. A detailed discussion is given for the extreme cases of thin-walled and solid cylinders. (auth)

16771 EXPERIMENTAL DETERMINATION OF THE FOURTH SOUND VELOCITY IN HELIUM II. Kenneth A. Shapiro and Isadore Rudnick (Univ. of California, Los Angeles). Phys. Rev., 137: A1383-91(Mar. 1, 1965).

Fourth sound is a pressure and density wave in He II, in which only the superfluid is in motion. Using packed rouge to lock the normal fluid, the existence of this wave mode was experimentally confirmed by measuring the temperature dependence of a plane-wave resonance in a closed-closed cylindrical acoustic resonator. The measured phase velocity has a temperature dependence which agrees within 1% with that predicted theoretically. Pulse measurements using 40-kc/sec sine-wave bursts further corroborate the existence of this type of wave. The absolute value of the fourth sound velocity is affected by the coherent multiple scattering of the wave from the superleak material. The results of Twersky's and Saxon's scattering theories are compared with the data. It is found that the equation $n = (2 - P)^{\frac{1}{2}}$, where n is the index of refraction and P is the porosity, fits the data within 3%. Values of the ratio of the superfluid to the He II density, derived from the fourth-sound data, agree within 2% with those obtained by other experimental techniques. (auth)

16772 ELECTRON CONTRIBUTION TO THE TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF CUBIC METALS. II. SUPERCONDUCTING METALS. B. T. Bernstein (American Standard Research Div., New Brunswick, N. J.). Phys. Rev., 137: A1404-9(Mar. 1, 1965).

A theory is presented to explain the difference in elastic shear constants between normal and superconducting metals as a function of temperature. The development is based upon the BCS theory of superconductivity in the weak-coupling limit and the quantum mechanical theory of elasticity discussed in the first article of this series. Expressions are presented for the first and second derivatives of the energy gap and critical field with respect to shear strains in terms of parameters for the normal state. Representative calculations are performed to show that the model chosen is capable of giving the correct order of magnitude and sign for the difference in elastic shear constants at absolute zero. It is also found that although the second derivative of the free-energy difference, with respect to shear strains, disappears at the superconducting critical temperature, the corresponding second derivative of the entropy difference is finite at the superconducting critical temperature and is proportional to the difference in elastic shear constants at absolute zero. (auth)

16773 SEARCH FOR SUPERCONDUCTIVITY IN α-CERIUM. T. F. Smith (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: A1435-7(Mar. 1, 1965).

The α modification of cerium, formed from the normal, room-temperature modification under a pressure of 10,000 atm, was cooled to 1.25°K and tested for superconductivity. The nature of the state of the $4f$ electron in α-cerium is discussed in relation to the absence of superconductivity. (auth)

16774 SUPERCONDUCTIVITY IN Cr_3Si-TYPE TERNARY PHASES WITH NIOBIUM AND GROUP VIII METALS. S. T. Zegler (Argonne National Lab., Ill.). Phys. Rev., 137: A1438-40(Mar. 1, 1965).

Ternary alloys having the Cr_3Si-type structure and the general composition $Nb_3Rh_{1-x}B_x$, where B is Co, Ru, Pd, Os, Ir, Pt, or Au were investigated for superconductivity down to 1.7°K. All the metals substituted for Rh in Nb_3Rh were found to increase the cell volume and, except for Pt and Au, to decrease the superconducting transition temperature. Substitutions of Pt or Au in suitable amounts increase the transition temperature, but not above that of the binary compounds Nb_3Pt and Nb_3Au. The data indicate that the transition temperature of Cr_3Si-type phases is increased as the valence electron-atom ratio increases from 6 to 6.5, but is decreased with increasing cell volume. (auth)

16775 WAVE-MODE MODIFICATION IN LIQUID HELIUM WITH PARTIALLY CLAMPED NORMAL FLUID. Gerald L. Pollack and J. R. Pellam (California Inst. of Tech., Pasadena). Phys. Rev., 137: A1676-84(Mar. 15, 1965).

When the equations of first and second sound are modified to correspond to wave propagation in the presence of viscous forces on the normal fluid, two wave modes re-

sult. In the limit of large viscous forces, second sound becomes an overdamped thermal mode with zero velocity, and first sound becomes an undamped (acoustic) mode with wave velocity v given to first order by $v^2 = (\rho_s/\rho)^2 c_1^2 + (\rho_n/\rho)^2 c_2^2$ in terms of usual symbols. In this investigation, the onset of wave-mode modification has been examined as degradation of pure second-sound pulses and standing waves in the presence of barriers. Normal fluid was partially clamped in the interstices of emery powder or rouge, with viscous drag controlled by employing several packing densities. The velocity of thermal signals sent through chambers filled with these small particles decreases, and the damping increases with smaller interstices. The theoretical wave velocities of the thermal and acoustic modes are obtained, as functions of temperature and a viscosity coefficient, from the modified wave equations. For suitably chosen constant values of the viscosity coefficient, the theoretical velocity of thermal waves is in approximate quantitative agreement with the observed pulse velocities, and the observations are interpreted in this way. Qualitatively observed attenuation is shown to be in agreement with the same theory. The effect of capacitive thermal losses to the barrier particles, and consequent possible degradation of incipient wave modes to thermal diffusion, is also analyzed. (auth)

16776 GENERALIZED GINZBURG-LANDAU THEORY OF SUPERCONDUCTING ALLOYS. L. Tewordt (Univ. of Illinois, Urbana). Phys. Rev., 137: A1745-9(Mar. 15, 1965).

The Ginzburg-Landau-Gorkov theory of superconducting alloys is generalized to arbitrary temperatures and magnitudes of the gap parameter $\Delta = |\Delta| \exp i\varphi$. However, the theory is still based on the assumption that the integral equation for the Green's function can be solved in powers of $v_s = (2eA - \nabla\varphi)/2m$ and successively higher space derivatives of $|\Delta|$ and v_s. The averaging over the positions of the impurities is carried out by means of the ladder-diagram technique developed by Abrikosov and Gorkov. The results are presented in terms of the free-energy functional. The form of this functional is found to be close to that proposed by Ginzburg-Landau if $|\Delta|$ is close to the BCS gap $\Delta_{BCS}(T)$ and varies slowly in space. A comparison of the magnitudes of the fourth- and second-order terms in the free-energy functional shows that the local theory is valid if: $|\Delta|$ and v_S vary slowly over distances ξ; and $\lambda_S = h/2mv_S > \xi$. In the dirty limit ($l \ll \xi_0$) the length ξ ranges from about $(l\xi_0)^{1/2}$ to $(T_c/T)(l\xi_0)^{1/2}$ as $|\Delta|$ varies from $\Delta_{BCS}(T)$ to zero. (auth)

16777 IRREVERSIBLE MAGNETIZATION OF HIGH-FIELD SUPERCONDUCTORS. H. E. Cline, C. S. Tedmon, Jr., and R. M. Rose (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 137: A1767-70(Mar. 15, 1965).

A model is presented which relates the experimentally determined critical current density to the irreversible magnetization of a hard superconductor. The internal field distribution in long cylinders and tubes in longitudinal applied fields is calculated from the critical current density data. The distribution of the induction B is related to the field distribution by the use of the ideal (reversible) type II magnetization curve. To illustrate the use of the model, critical current density and magnetization measurements were performed on a niobium specimen in both highly annealed and strained states. Magnetization measurements were also made on niobium tubes of various wall thicknesses. The shape of the magnetization curves are correctly predicted. Details of the magnetization curve near H_{c2} for the strained specimen, which were not predicted by previous models, were partially verified. (auth)

16778 TEMPERATURE DEPENDENCE OF THE GINZBURG-LANDAU COEFFICIENT IN TYPE-I SUPERCONDUCTORS. Arthur Paskin, Myron Strongin, Paul P. Craig, and Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: A1816-21(Mar. 15, 1965). (BNL-8525; BNL-8409)

Making use of surface superconductivity measurements, it is possible to obtain relatively precise values for the Ginzburg-Landau parameter κ as a function of temperature in certain type-I materials. The a-c susceptibility was measured to obtain H_{c3}, and the d-c magnetization was measured to obtain the bulk critical field, for Ta and three dilute alloys of Bi in Pb. The data are sufficiently accurate to distinguish between the various existing theories for κ; the Ginzburg extension of the Ginzburg-Landau theory to low temperature predicts $\kappa(t) = \kappa(0)_{G-L}(1 + t^2)^{-1}$, while Gorkov predicts $\kappa(t) = \kappa(0)_G(1 - 0.24t^2 + 0.04t^4)$, where t is the reduced temperature T/T_c. It is found that the data fall on smooth curves which lie between the two theoretical predictions. Bardeen has used the two-fluid model to generate a temperature-dependent set of equations for the free energy, which yields the Ginzburg-Landau equations in the limit of $t \to 1$. Using the Bardeen two-fluid formulation, it is found that $\kappa(t) = \kappa(0)_B(1 + t^2)^{-1/2}$. It is also found that the data fit the two-fluid temperature dependence more closely than they fit either the Gorkov or the Ginzburg relation. (auth)

16779 SUPERCONDUCTIVE TRANSITIONS IN FAST-PULSED MAGNETIC FIELDS. R. B. Flippen (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Rev., 137: A1822-5(Mar. 15, 1965).

Values of H_{c2} for Nb–25% Zr and Nb_3Sn measured in longitudinal pulsed magnetic fields having values of dH/dT of 10^9–10^{11} Oe/sec are found to be less than 25% of that of the static field values. The increasing- and decreasing-field values of H_{c2} are essentially the same. Measured values of H_{c2} increase rapidly as sample diameters are reduced below 0.04 mm. These values of H_{c2} are independent of temperature between 1.4 and 4.2°K. A discussion of these results shows that neither eddy-current Joule heating nor generation of critical currents by the changing field can explain the differences observed in values of H_{c2} measured in fast-pulsed and static magnetic fields. Measurements of Cu-clad Nb–25% Zr support these conclusions. Possible explanations of the results of these measurements are discussed in terms of present theories, which are shown to be inadequate to explain the phenomena. (auth)

16780 BOSE-EINSTEIN CONDENSATION IN NARROW CHANNELS. Brij M. Khorana and D. H. Douglass, Jr. (Univ. of Chicago). Phys. Rev., 138: A35-9(Apr. 5, 1965).

The problem of the transition temperature of liquid helium in narrow channels was considered by using the ideal Bose-Einstein gas as a model. It was found that for a channel of square cross section (D × D) and length L, the transition temperature T_c is given by the expression $T_c/T_{cB} = (0.84\ \text{Å}^{-1})D^2/L$ under the conditions that $D^2/L \ll \lambda$, where λ is the thermal de Broglie wavelength, and T_{cB} is the transition temperature in the case of an infinite volume. (auth)

16781 CRITICAL MAGNETIC FIELD OF A THIN FILM OF SUPERCONDUCTOR. G. Rickayzen (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 138: A73-8(Apr. 5, 1965).

A theory of the critical field of a thin superconductive film is given based on the assumption that this is the field in which the normal state becomes unstable to the formation of Cooper pairs. Only the case where l, the mean free path for the electrons is much less than d, the thickness of the film, and where the coherence length is less than d^2/l is discussed. The resulting field for temperatures near T_c agrees with that predicted by the Ginzburg-Landau theory. At lower temperatures, the field is greater than that predicted by an earlier theory of Maki and appears to be in better agreement with the experimental results. (auth)

16782 THEORY OF THE ELECTRONIC THERMAL CONDUCTIVITY OF SUPERCONDUCTORS CONTAINING PARAMAGNETIC IMPURITIES. Leonard W. Gruenberg (Faculte des Sciences, Orsay, France). Phys. Rev., 138: A78-84(Apr. 5, 1965).

The electronic thermal conductivity κ of superconductors containing paramagnetic impurities is discussed from two points of view: the Bardeen-Rickayzen-Tewordt Boltzmann equation and the Kubo formula. The major results are: κ_s/κ_n decreases with temperature with a nonvanishing slope

at $T = T_c$. The slope $\partial(\kappa_s/\kappa_n)/\partial(T/T_c)|_{T=T_c}$ initially increases and then decreases as the impurity concentration is increased. At low temperatures, providing the concentration is not too high, κ_s is proportional to $e^{-\beta\omega_0}$, where ω_0 is the reduced energy gap. There is no observable singularity at the temperature at which the gap appears. In the extreme gapless region, κ_s/κ_n decreases linearly with temperature. The Boltzmann-equation result is asymptotically correct in the very dilute limit. Corrections are of the order ξ_0/L^M where ξ_0 is the coherence length and L^M the mean free path due to magnetic scattering. (auth)

16783 ORDERING IN SOLID HYDROGEN. A. Danielian (Columbia Univ., New York). Phys. Rev., 138: A282-7 (Apr. 5, 1965).

It is shown that in the case of the model for solid orthohydrogen considered, the ground-state superlattice structure, produced by the electrostatic quadrupole interactions, may be derived exactly. It consists essentially of two unequal sublattices: one consisting of molecules A in the state M = 0 and the other consisting of molecules B in either of the states M = ±1, the latter being twice as many as the former. The configuration on each triangular plane, normal to the axis of symmetry of the lattice, is such that each A molecule is surrounded by six B molecules, and each B molecule is surrounded by three A molecules and three B molecules. The transition temperature of the system is found to be 5.8°K in the zeroth approximation and 3°K in a tetrahedral approximation, the latter being in agreement with the experimental estimate. (auth)

16784 NEGATIVE IONS IN LIQUID HELIUM II. Boyce Burdick (United Aircraft Corp., East Hartford, Conn. and Yale Univ., New Haven). Phys. Rev. Letters, 14: 11-13 (Jan. 4, 1965).

The behavior of an electron in liquid helium is investigated, using the model of an electron propagating in a periodic lattice. The results support the hypothesis that negative ions in liquid helium II are self-trapped electrons. (D.C.W.)

16785 THEORY OF THE INTERACTION OF IONS AND QUANTIZED VORTICES IN ROTATING HELIUM II. R. J. Donnelly (Univ. of Chicago). Phys. Rev. Letters, 14: 39-41(Jan. 11, 1965).

The trapping of ions in vortices in rotating helium II is studied. The capture cross section for positive and negative ions with radii of 6.3 and 12.1 Å and with equal masses is calculated, together with the escape probability. (D.C.W.)

16786 MAGNETIC FIELD DEPENDENCE OF THE MICROWAVE SURFACE IMPEDANCE IN PURE SUPERCONDUCTORS. Kazumi Maki (Univ. of Chicago). Phys. Rev. Letters, 14: 98-102(Jan. 25, 1965). (COO-264-227)

It is shown that many of the features of the experimentally observed field dependence of the surface impedance follow directly from the current microscopic theory. The surface impedance in pure superconductors in magnetic fields is calculated. The following limiting cases are considered: the low-temperature region where $\Delta \gg T$; the higher temperature region where $(\omega T)^{1/3} \ll \Delta \simeq T$; and near the critical temperature where $(\omega T)^{1/3} \gg \Delta$. Δ is the temperature-dependent ordering parameter and ω is the angular frequency of the incident electromagnetic wave. (D.C.W.)

16787 STRONG-COUPLING SUPERCONDUCTOR AT NONZERO TEMPERATURE. D. J. Scalapino, Y. Wada, and J. C. Swihart (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 14: 102-5(Jan. 25, 1965).

The energy dependence of the effective electron-phonon coupling constant for lead is calculated, using an approximate form of the matrix element suggested by Harrison. The frequency dependence of the gap function at nonzero temperature is determined, and an anomaly in the effective tunneling density of states due to recombination processes is discussed. (D.C.W.)

16788 SOLUTION OF THE GAP EQUATION FOR Pb, Hg, AND Al. J. C. Swihart, D. J. Scalapino, and Y. Wada (Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev. Letters, 14: 106-8(Jan. 25, 1965).

The energy gap for Al, Pb, and Hg was calculated as a function of temperature, together with the ratio $2\Delta_0/kT_c$, where Δ_0 is the gap at T = 0. The condensation energy at T = 0 and the temperature dependence of the critical field were also obtained, as well as the contribution to the normal-state effective mass from the electron-phonon interaction. The results were compared with experimental observations. (D.C.W.)

16789 LEAD PHONON SPECTRUM CALCULATED FROM SUPERCONDUCTING DENSITY OF STATES. W. L. McMillan and J. M. Rowell (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 14: 108-12(Jan. 25, 1965).

A procedure is outlined for inverting the gap equation to obtain a phonon density of states and coupling constants from experimental data on the electron density of states. The strength of the electron-phonon coupling, the screened Coulomb interaction, and the phonon density of states in lead are obtained. (D.C.W.)

16790 VISCOSITY OF TYPE-II SUPERCONDUCTORS. M. J. Stephen and J. Bardeen (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 14: 112-13 (Jan. 25, 1965).

The viscosity coefficient of type-II superconductors is investigated. An expression similar to the empirical expression is obtained. (D.C.W.)

16791 SUPERCONDUCTING ADAPTIVE LOGIC. Leonidas J. Jones (Duke Univ., Durham, N. C.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 102-3(Jan. 1965). (TID-21298)

Proposed use of thin-film superconducting devices as adaptive logic elements is discussed. A complete superconducting adaptive threshold element consists of one weighing loop for each binary input, a single superconducting secondary loop, and a single threshold device. Initial test results are reported. (R.E.U.)

16792 THE FIFTY-FIFTH KELVIN LECTURE. SUPERCONDUCTING MAGNETS. A. B. Pippard (Univ. of Cambridge, Eng.). Proc. Inst. Elec. Engrs., (London), 111: 2105-10(Dec. 1964).

Possible uses of superconductors for producing high magnetic fields without great energy expenditure are surveyed. Technical problems in refrigerating to and maintaining superconducting temperatures are mentioned, and the cases where superconducting magnets may prove economically useful — for fields between 25 and 80 kG, especially over a large volume — are investigated. Basic properties of types I and II superconductors are reviewed, with discussions of coherence, superconducting transitions, and effects of heat treatments on current-carrying capacity. (M.J.T.)

16793 ON SUPERCONDUCTIVITY OF THE FALICOV-COHEN MODEL. Sadao Nakajima (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 856-7(Nov. 1964).

The model for a gapless superconductor is discussed. (C.E.S.)

16794 ^{3}He CRYOSTAT WITH ADSORPTION PUMPING. C. F. Mate, R. Harris-Lowe, W. L. Davis, and J. G. Daunt (Ohio State Univ., Columbus). Rev. Sci. Instr., 36: 369-73 (Mar. 1965).

A ^{3}He cryostat is described in which temperatures down to 0.3°K were obtained by pumping the ^{3}He refrigerant bath with activated charcoal at a temperature of 1.3°K. The performance characteristics of the adsorption pump are described in some detail, and a discussion is given of the extent to which the speed, adsorptive capacity, and cooling requirements of such a pumping system can be predicted by calculation. (auth)

16795 MAGNETIC FLUX JUMPS IN SUPERCONDUCTING 3Nb–Zr ALLOY WIRES. Tadao Fukuroi and Tetsuo Fukase (Research Inst. for Iron, Steel and Other Metals, [Tokyo]). Sci. Rept. Res. Inst., Tohoku Univ., Ser. A, 16: 132-8(Oct. 1964).

The magnetic field strength in the center of three types of superconducting solenoids wound with Nb–Zr wire was measured in the course of a gradual variation of the external magnetic field. The trapping and penetration of magnetic filaments were studied by observing flux jumps. Flux jumps occurred in smaller and more frequent steps as the external magnetic field became stronger. (D.C.W.)

16796 EFFECT OF PRECIPITATION PROCESS ON SUPERCONDUCTING CRITICAL PROPERTIES OF LEAD–ANTIMONY ALLOYS. Chi-jui Chang, Hsiago-wen Tsao, and Wei-yen Kuan. Sci. Sinica (Peking), 14: 306-9(Feb. 1965).

The effect of precipitation from solid solution on the critical current density-magnetic field curves of Pb–Sb alloys was investigated by measuring the curves in various stages of precipitation. The results show that the high critical magnetic field and large critical current density have completely different origins. (D.C.W.)

16797 MEASUREMENT OF I_c–H_c–CURVES ON HIGH-FIELD SUPERCONDUCTORS IN SHORT-TIME MAGNETIC FIELD PULSES. H. Benz (Eidgenossische Technische Hochschule, Zurich). Z. Angew. Math. Phys., 15: 659-60 (Nov. 25, 1965). (In German)

A method is developed, which not only yields information about the static I_c–H_c behavior, but also gives evidence concerning the critical current expected in the operation of superconducting coils. Nb–Zr wires were investigated for different current and field conditions, and the resulting curves are presented. (L.B.S.)

16798 ON STRATIFICATION IN SOLID PHASE H_2–HD AND D_2–HD SYSTEMS. R. F. Bulatova and V. S. Kogan. Zh. Eksperim. i Teor. Fiz., 48: 130-2(Jan. 1965). (In Russian)

The mutual solubility of D_2 and HD molecules and of H_2 and HD molecules at 4.2°K is determined by x-ray diffraction studies. It is shown that a restricted solubility occurs in these systems just as in the D_2–H_2 system. The stratification region in the D_2–HD and H_2–HD systems is not symmetrical with respect to concentration and is shifted towards the heavier isotopes. (auth)

16799 SMALL-SIZE SUPERCONDUCTORS IN A STRONG MAGNETIC FIELD. A. I. Larkin (Inst. of Physics and Tech., Moscow). Zh. Eksperim. i Teor. Fiz., 48: 232-41(Jan. 1965). (In Russian)

Spherical and cylindrical superconductors whose size is smaller than the penetration depth are considered. The field strength for which the gap in the excitation spectrum vanishes and the field strength for which pairing vanishes are determined. The dependence of the magnetic moment on the field strength is determined. The dependence of the Knight shift on the particle size and field strength is obtained for the case when the field is not small compared with the critical field strength. (auth)

16800 ISOTOPIC SOLUTIONS OF SOLID HELIUM. P. G. Klemens, R. de Bruyn Ouboter, and C. le Pair (Westinghouse Research Labs., Pittsburgh). 8p. (CONF-651-46)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The heat of mixing of helium isotopes in the solid state is estimated from the elastic constants of solid helium and the molar volume of the two pure isotopes. Good agreement with experimental data is obtained. (auth)

16801 A REALIZATION OF A LONDON-CLARKE-MENDOZA TYPE REFRIGERATOR. P. Das, R. de Bruyn Ouboter, and K. W. Taconis. 6p. (CONF-651-64)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A refrigerator is described, which uses the heat of mixing at constant osmotic pressure between ^{3}He and ^{4}He. In preliminary runs, a temperature of 0.22°K was obtained. (D.C.W.)

16802 CRITICAL FIELDS OF SUPERCONDUCTING FILMS. F. Odeh and W. Liniger (IBM Watson Research Center, Yorktown Heights, N. Y.). 13p. (CONF-651-47)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The critical fields of thin superconducting films are calculated, considering non-zero temperatures and a finite mean free path. The relation of the Bardeen equations to Gorkov's derivation of the Ginzburg-Landau equations in the limit of films with a thickness smaller than the coherence length is studied. It is shown that the exact form in which the nonlocality is incorporated into the equations is rather unimportant in this limit. (D.C.W.)

16803 DYNAMIC VORTEX EFFECTS IN THIN SUPERCONDUCTORS. J. M. Mochel and R. D. Parks (Univ. of Rochester, N. Y.). 10p. (CONF-651-70)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The results of observations on the electrical behavior of tin film (800 Å thick) constrictions of 1 to 5 μ in a perpendicular magnetic field are presented; and a model is outlined, attributing the results to vertex motion within the film. (D.C.W.)

16804 ON THE INTERMEDIATE STATE OF A TYPE II ENCLOSED SUPERCONDUCTOR. Robert I. Gayley (New York State Univ., Buffalo). 8p. (CONF-640803-1)

From Conference on the Physics of Type II Superconductivity, Cleveland.

The possible occurrence of an intermediate state in thermodynamic equilibrium was investigated by analyzing a coaxial cable arrangement in which the outer superconducting shell was assumed to have the higher transition temperature, while its critical field exceeds the upper critical field of the inner rod at any temperature. (D.C.W.)

16805 MAGNETIC PROPERTIES OF A CYLINDRICAL ENCLOSED SUPERCONDUCTOR. Robert I. Gayley (New York State Univ., Buffalo). 15p. (CONF-640803-2)

From Conference on the Physics of Type II Superconductivity, Cleveland.

The magnetic behavior of the inner superconducting rod of a coaxial-cable arrangement in which the outer superconducting shell has the higher transition temperature and, at any temperature, the higher critical field is studied for the case in which flux is trapped by the superconducting shell. (D.C.W.)

16806 ULTRASONIC ABSORPTION IN SUPERCONDUCTING LANTHANUM. Tore Olsen, Lewis T. Claiborne, and Norman G. Einspruch (Texas Instruments Inc., Dallas). 8p. (CONF-651-81)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Measurements on polycrystalline La, a hard superconductor, were undertaken to study the microscopic processes responsible for the oscillations in the temperature dependence of ultrasonic attenuation. A pulse echo method was used to measure the attenuation at 6 to 1.2°K. The factors influencing the magnitude of the peaks are discussed. It is concluded that the absorption structure can be explained by a macroscopic model, that a size effect is indicated, and that the whole sample is apparently participating in a collective mode. (D.L.C.)

16807 SUPERFLUID FLOW IN LIQUID HELIUM. W. M. van Alphen, W. Vermeer, K. W. Taconis, and R. de Bruyn Ouboter (Kamerlingh Onnes Laboratorium, Leiden). 8p. (CONF-651-66)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The flow characteristics of superfluid He were studied in adiabatic gravitational flow. A normal flow was superimposed on the superflow. Three cases were considered: pure superflow, normal flow with superflow in the same direction, and normal flow with counter superflow. (D.L.C.)

16808 SOLIDIFICATION OF ^{3}He–^{4}He MIXTURES. C. le Pair, K. W. Taconis, R. de Bruyn Ouboter, E. de Jong, and J. Pit (Kamerlingh Onnes Laboratorium, Leiden). 9p. (CONF-651-65)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The melting lines of ^{3}He–^{4}He mixtures were measured over the entire concentration range at 0.5 to 1.3°K and 23.5 to 38 atm. The results are presented in the form of P-T and T-X diagrams, and are discussed individually for each of the experimental pressures. (D.L.C.)

16809 EVIDENCE FOR A QUADRUPLE POINT IN He^3–He^4 MIXTURES. F. P. Lipschultz, P. M. Tedrow, and D. M. Lee (Cornell Univ., Ithaca, N. Y.). 10p. (CONF-651-60)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Results are reported of strain gage measurements of the freezing curves of dilute mixtures of ^{3}He in ^{4}He. At temperatures below 0.37°K, these curves can have positive slopes, suggesting the existence of a quadruple point. (D.L.C.)

16810 ON THE PHASE DIAGRAM OF He^3–He^4 MIXTURES. P. M. Tedrow and D. M. Lee (Cornell Univ., Ithaca, N. Y.). 19p. (CONF-651-59)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The Gibbs phase rule was used to determine the phase diagram of ^{3}He–^{4}He mixtures near the liquid–solid phase boundary below 2°K. Univariant curves were found on the P-T diagram which contained three of the following five phases: L_1, L_2, bcc_1, bcc_2, and hcp. Two quadruple (invariant) points were also found: bcc_1–hcp–L_1–L_2 and bcc_1–hcp–L_2–bcc_2. A T-X diagram was obtained using strain gages at 30 atm and compared with other T-X diagrams at 20 to 27 atm. (D.L.C.)

16811 THE THERMAL CONDUCTIVITY OF b.c.c. He^4 AND OF ISOTOPIC MIXTURES. R. Berman and S. J. Rogers (Clarendon Lab., Oxford). 11p. (CONF-651-61)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The temperature variation of the thermal conductivity of solid ^{4}He was measured at constant volume in both the hcp and bcc phases. The sudden changes in thermal conductivity at the phase transitions show that for all densities >0.1932 g/cm^3 only the hcp phase exists, and for all densities <0.1906 g/cm^3 only the bcc phase exists. P-T phase diagrams were constructed for ^{4}He–^{3}He mixtures containing 6.5 and 13% ^{3}He concentrations. It is seen that the bcc phase extends to below 1°K for the 6.5% but not for the 13% concentration. (D.L.C.)

16812 SURFACE SUPERCONDUCTIVITY AND SUPERCOOLING IN WEAK AND STRONG COUPLING TYPE I SUPERCONDUCTORS. Manuel Cardona and Bruce Rosenblum (RCA Labs., Princeton, N. J.). 12p. (CONF-651-62)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Observations of surface superconductivity and supercooling were made for Hg–Cd, Pb, and Pb–Tl, using microwave techniques. Supercooling was found in several materials with $\kappa C\sqrt{2} < 1$. The temperature dependence of H_{c3}/H_c ($= \kappa C\sqrt{2}$) and the angular dependence of the critical field for the disappearance of surface superconductivity are given. (D.L.C.)

16813 SUPERCONDUCTIVITY IN GeTe AND THE MONOXIDES OF Ti AND Nb. J. K. Hulm (Westinghouse Research Labs., Pittsburgh), C. K. Jones, R. Mazelsky, R. C. Miller, R. A. Hein, and J. W. Gibson. 9p. (CONF-651-51)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The maximum observed transition temperature of GeTe was raised to 0.41°K by increasing the carrier concentration through the use of Ag as a doping agent. The TiO system is found to exhibit superconductivity for compositions in the range of $TiO_{0.9}$ to $TiO_{1.10}$. In this composition range, the transition temperature is a strong function of the composition increasing from 0.22 to 1.05°K for the above compositions. For a composition of $TiO_{1.15}$ and above, no superconductivity is observed above 0.08°K; thus this system exhibits a rather dramatic cut-off of superconductivity. NbO is found to be a superconductor with a transition temperature of 1.25°K. (auth)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstracts 16367, 16843, 16857, and 17232.

16814 (AERE-R-4776) A COMPILATION OF EXPERIMENTAL AND THEORETICAL NEUTRON SPECTRA. R. H. Jones, ed. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1964. 65p. Dep.; $1.80(BIS), 9s.(HMSO).

Neutron spectra in moderator–absorber systems are tabulated, as measured and calculated. Pulsed-source and chopper techniques are used. The systems studied include B, Cd, or Pu in H_2O; B–D_2O; and Cd or Cu in graphite. (T.F.H.)

16815 (CEA-R-2278) THEORIE DU COEFFICIENT DE DIFFUSION DES NEUTRONS DANS UN RESEAU COMPORTANT DES CAVITES. (Theory of the Diffusion Coefficient of Neutrons in a Lattice Containing Cavities). Pierre Benoist (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 176p. Dep.(mn).

Thesis submitted to Université, Paris.

Previously a simple and general formulation of the diffusion coefficient, which defines the mode of weighting of the mean free paths of the various media, in introducing the collision probabilities in each medium, was established. This expression is demonstrated again through a more direct method, and the velocity is introduced; new terms are emphasized, the existence of which implies that the representation of the diffusion area as the mean square of the straight line distance from source to absorption is not correct in a lattice. However these terms are of small enough an order of magnitude to be treated as a correction. The general expression also shows the existence, for the radial coefficient, of the series of angular correlation terms, which is seen to converge very slowly for large channels. The term by term computation which was initiated in the first work was then interrupted and a global formulation, which emphasizes a resemblance with the problem of the thermal utilization factor, was adopted. An integral method, analogous to that used for the computation of this factor, gives the possibility to establish new and simple practical formulas, which require the use of a few basic functions only. These formulae are very accurate as seen from the results of a variational method which was studied as a reference. Various correction effects are reviewed. Expressions which allow the exact treatment of fuel rod clusters are presented. The theory is confronted with various experimental results, and a new method of measuring the radial coefficient is proposed. (auth)

16816 (EUR-2187.e) THESIS 2—A FORTRAN CODE FOR THE CALCULATION OF THERMAL SPECTRA AND CROSS SECTIONS. C. Mongini-Tamagnini and C. Ponti (European Atomic Energy Community, Ispra (Italy), Joint Nuclear Research Center and European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). 1964. 50p. Dep.(mn).

The code THESIS 2 numerically solves the integral balance equation for thermal neutrons in homogeneous media and provides the corresponding spectrum and average multigroup thermal cross sections. The scattering kernel can be computed by the code itself, in the framework of the free gas model, or can be given in input. Heterogeneous media are also treated, by introducing the energy-dependent self-shielding factors of each isotope. An external (positive or negative) neutron source can be considered. (auth)

16817 (GA-5554) DIFFERENTIAL NEUTRON THERMALIZATION. Annual Summary Report, October 1, 1963–September 30, 1964. W. L. Whittemore (General Atomic, San Diego, Calif.). Oct. 20, 1964. Contract AT(04-3)-167. 113p. Dep.; $4.00(cy), 3(mn) CFSTI.

A neutron velocity selector is used to study the inelastic scattering of monoenergetic neutrons in a variety of materials. The scattering into various angular directions between 30 and 150° has been studied for incident neutrons with energies up to 1.0 ev. Because of the ability of this apparatus to study details of single scattering events with neutrons having energies significantly higher than are available with reactor-based experiments, most of the work was done for $E_0 > 0.20$ ev. The exact incident energy was chosen to optimize the ability to study various chemical rotation and vibration levels in this higher energy region. The technical details of the experimental apparatus are discussed. Numerous details are given for neutron interactions in liquid para-hydrogen, polyethylene, zirconium hydride, and hydrides of other rare earth metals. Attention is devoted to neutron scattering by liquid para-hydrogen, the scattering kernel for polyethylene, neutron interactions in zirconium hydride, and hydrogen and deuterium binding in zirconium, yttrium, and lanthanum. (auth)

16818 (ORNL-3622) 05R, A GENERAL-PURPOSE MONTE CARLO NEUTRON TRANSPORT CODE. D. C. Irving, R. M. Freestone, Jr., and F. B. K. Kam (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 216p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

The 05R code is a highly versatile Monte Carlo neutron transport code covering the energy range from 77.13 Mev to 0.070×10^{-3} ev. It is distinguished by its detailed representation of cross section data. In this representation the energy range is divided into 40 supergroups, each a factor of 2 apart, and each supergroup is divided into n subgroups, where n is any power of 2 from 1 to 512. Practical use of so much information is made by storing in the machine memory only the cross sections for a single supergroup and processing neutrons in batches of from 200 to 2000 entirely through the energy range of the supergroup. Cross sections for the next lower supergroup are then read in from tape and the process repeated. A very general geometry routine permits the treatment of complicated configurations. As many as 16 media are permitted and boundaries may be either planes or quadric surfaces, arbitrarily oriented and intersecting in arbitrary fashion. The 05R code does not permit absorption of neutrons. Instead, the probability of absorption is taken into account by a reduction in the statistical weight of a neutron at each collision. Both splitting and Russian roulette are allowed, at the option of the user. Fast and/or thermal fissioning are permitted in appropriate systems. Anisotropic scattering, utilizing a technique for selecting from anisotropic distributions which gives the same accuracy as a straightforward selection from a Legendre expansion but requires considerably less computer time, is permitted. No analysis is performed by 05R. Instead, its output consists of one or more collision tapes which contain, for every collision, any or all of 34 distinct parameters describing the event. Analysis of these tapes to extract the information desired is done by separate routines which must be written by the user. Included in the code package are efficient random number generating routines and codes for performing a variety of manipulations with cross sections. The latter include routines for preparing master tapes, deleting specific data from master tapes, performing cross section arithmetic, printing master tapes, preparing cross section data in the form needed by 05R, and preparing an input tape for the Calcomp plotter for drawing cross section curves. The code described is written for the CDC-1604-A computer. A parallel version exists for the IBM-7090 machine, and is the subject of a separate report. The report includes a detailed users' manual, input instructions for all parts of the code package, program descriptions and flow charts, the derivation of the anisotropic scattering selection technique, a glossary of terms, and a full scale sample problem against which the proper operation of the code may be checked. (auth)

16819 (ORNL-3714(Vol.I)) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 1, 1964. (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 102p. Dep.; $4.00(cy), 2(mn) CFSTI.

Sections are included on nuclear and reactor physics, reactor shielding, radiation shielding information center, radiation detector studies, and water desalination studies. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 15872, 15981, 16855, 17157, and 17158.

16820 (ORNL-3714(Vol.II)) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 1, 1964. (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 57p. Dep.; $3.00(cy), 2(mn) CFSTI.

Information is presented in sections on theoretical studies of high-energy radiation shielding, experimental studies of high-energy radiation shielding, and radiation detector studies. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 15873, 17159, and 17160.

16821 SPATIAL DISTRIBUTION OF 3 AND 15 Mev NEUTRONS IN BERYLLIUM. S. P. Belov, V. A. Dulin, Yu. A. Kazanskii, and S. G. Tsypin. At. Energ. (USSR), 18: 67-8(Jan. 1965). (In Russian)

Spatial distributions of 3- and 15-Mev neutrons in Be were studied in order to determine beryllium shielding properties. Reactions $D(d,n)^3He$ and $T(d,n)^4He$ were used as neutron sources. Fission chambers with ^{235}U and ^{232}Th were used for measuring 3-Mev neutrons. In addition to the fission chambers, threshold tracers $^{31}P(n,p)$, $^{27}Al(n,p)$, $^{28}Si(n,p)$, and $^{27}Al(n,\alpha)$ with the threshold energies: 3, 5, 5, and ~7 Mev respectively were used for measuring 15-Mev neutrons. (R.V.J.)

16822 IMPROVED CALIBRATION OF A Ra Be(α,n) AND AN Am Be(α,n) NEUTRON SOURCE. K. W. Geiger and A. P. Baerg (National Research Council, Ottawa). Can. J. Phys., 43: 373-8(Feb. 1965).

Since an increase in neutron emission takes place because of the growth of ^{210}Po, the source was recalibrated by the manganese-bath method using more precise counting techniques. The improvement in accuracy is almost entirely due to the higher precision of bath counting and ^{56}Mn calibration. The remaining uncertainty is mainly in the cross sections and correction for fast neutron capture. (F.S.A.)

16823 OUTPUT SPECTRUM FROM 14-Mev NEUTRON GENERATORS. RAPID ESTIMATION AND INFLUENCE IN CROSS-SECTION MEASUREMENTS AND ACTIVATION ANALYSIS. E. Ricci (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 41-52(Jan. 1965).

Neutron generators, which use the reaction $^3H(d,n)^4He$, are being used extensively in 14-Mev neutron cross-section determinations and in activation analysis. The frequent assumption that the generated neutrons are monoenergetic is not always valid. A simple, approximate method to estimate the neutron spectra is given. The discussion is illustrated by a practical example. The neutrons impinging on a sample are divided into four groups. The energy ranges of each of these groups are obtained by scattering calculations; the corresponding neutron percentages result from probability considerations. The influence of the 14-Mev neutron spectrum in flux measurements, cross-section determinations, and activation analysis is discussed. Means to appraise irradiation geometries and to calculate and correct for experimental errors are also given. (auth)

16824 TRANSIENT SPECTRA IN GRAPHITE. A. K. Ghatak and H. C. Honeck (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Energy: Pt. A and B, 19: 1-6(Jan. 1965). (BNL-8267)

The transient spectra in graphite following a pulse of fast neutrons is calculated by solving numerically the time and energy-dependent Boltzmann equation. The asymptotic spectra are compared with fundamental mode eigenfunction, and the existence of a discrete resolvable eigenvalue is discussed. Parks' model for graphite and multigroup diffusion theory is used. (auth)

16825 A REMARK ON THE INTEGRAL MEASUREMENT OF THERMAL NEUTRON SPECTRA. Keiji Kanda and Akira Furuhashi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 1: 363-4(Dec. 1964).

The orthogonal expansion method proposed by Lanning (Trans. Am. Nucl. Soc., 6, 1, 35 (1963)) to deduce thermal neutron spectra from thermal neutron activation data is discussed. An improvement on this technique is proposed, which leads to a simpler treatment of the experimental data and to a more accurate description of the spectrum. (C.E.S.)

16826 ANISOTROPIC SCATTERING APPROXIMATIONS IN THE MONOENERGETIC BOLTZMANN EQUATION. D. K. Lathrop (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 21: 498-508(Apr. 1965). (LA-DC-6522)

The effects of anisotropic scattering approximations in the monoenergetic transport equation are evaluated by calculating discrete eigenvalues, fluxes due to a plane source, and slab critical half-thicknesses, all for homogeneous media. Relative to P_2 scattering approximation results, which are deemed accurate because of their agreement with P_4 solutions, the simple transport approximation overestimates eigenvalues and underestimates half-thicknesses in multiplying media, while a P_1 scattering approximation underestimates eigenvalues and overestimates thicknesses, but with smaller error. In the plane source problem, where the detailed flux behavior is observed, the transport approximation is even less accurate; but an extended transport approximation is found to be much more adequate. In overall effectiveness, in order of increasing accuracy, the approximations considered are ranked as follows: transport, forward-backward, first-order Legendre, extended transport, and higher-order Legendre. Some evidence is given to indicate that, even for severely anisotropic scattering, relatively low-order Legendre approximations are sufficient to include anisotropic scattering effects. (auth)

16827 DOPPLER EFFECT CALCULATIONS WITH INTERFERENCE CORRECTIONS. R. N. Hwang (Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 523-35(Apr. 1965).

Because of great concern about the effect of resonance interactions on the Doppler effect calculations, extensive studies were made for various dilute systems. A simplified method which allows the simultaneous occurrence of more than one type of interference was developed to calculate the temperature-dependent cross sections. Consequently, the numerical work involved is simplified considerably. Calculations were made for typical $^{239}Pu-^{238}U$, $^{235}U-^{238}U$, and $^{239}Pu-^{238}U-^{240}Pu$ systems. The results of these calculations seem to indicate that the resonance interference will substantially increase the negative Doppler effect of the system as compared to the case in which resonance interferences are ignored. (auth)

16828 A PHASE INTEGRAL STUDY OF NEUTRON THERMALIZATION IN GRAPHITE. Ajoy K. Ghatak (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 21: 580-2(Apr. 1965). (BNL-8396)

The diffusion equation with the scattering operator represented by a differential operator of second order was solved by the WKB method. The diffusion parameters were obtained, and the thermal neutron spectra for graphite poisoned by a 1/v absorber were calculated. The spectra were compared with measurements. (D.C.W.)

16829 SLOWING-DOWN OF NEUTRONS BY MIXTURES. V. C. Boffi and F. Knoke (Scuola di Perfezionamento in Fisica, Rome and Universita, Rome). Nuovo Cimento (10), 35: 1160-81(Feb. 16, 1965).

The exact and asymptotic solutions of the transport equation which governs the stationary energy distribution of neutrons slowed down by a mixture of different elements are obtained in the case of a general scattering and capture law. Specific results are shown for particular cases of the dependence of the cross sections on the neutron velocity. (auth)

16830 APPROACH TO EQUILIBRIUM OF A NEUTRON GAS. Charles S. Shapiro and Noel Corngold (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: A1686-96 (Mar. 15, 1965). (BNL-8522)

The relaxation constants (time eigenvalues) associated with the time-dependent Boltzmann equation for the relaxation of a neutron gas in contact with a heat bath (moderating material) were calculated. The eigenvalues were calculated by explicit and implicit matrix methods, and for monoatomic-gas and crystalline models of the moderator. The discrete eigenvalues were found to lie in a finite piece of the λ axis. The results strongly suggest that in many crystalline moderators, only the fundamental eigenvalue exists. In these cases, the approach to equilibrium is not exponential. (auth)

16831 LOWER BOUNDS FOR ALL EIGENVALUES OF THE NEUTRON TRANSPORT EQUATION. Chun Lin. Sci. Sinica (Peking), 13: 2009-10(Dec. 1964).

A brief calculational result is presented. (R.E.U.)

16832 ON THE ELECTRONIC COLLIMATION OF NEUTRONS FROM REACTION $D(d,n)He^3_2$. A. P. Bordulya and S. P. Sitko (Kiev State Univ.). Ukr. Fiz. Zh., 9: 912-14(Sept. 1964). (In Ukrainian)

A CsI crystal scintillation detector with a foil coated with a 50 to 70 Å thick Al layer, capable of recording deuteron energies up to 100 kev was used for the electronic collimation of neutrons generated in the $D(d,n)^3He_2$ reaction. It was assumed that at energies ranging from 0 to 0.005 Mev, the energy losses in the aluminum layer, (dE/dx), are porportional to $E^{-\frac{1}{2}}$. Proton tracks in the 0.005 to 0.69 Mev range were numerically integrated according to $R = \int_{0.005}^{E} (dR/dE)\, dE$, determining the proton trajectories by the working formula R (in mg/cm²) = $418.6 \int_{0.005}^{E} (1/\epsilon a)\, dE$. From the tabulated results of the collimation it can be shown that the thin aluminum-coated layer on the supporting plastic foil, prepared for the purpose of collimating neutrons from D-D reactions is capable of recording selectively the $^3He_2$ particles and the angular distribution of the neutrons with a coefficient of separation close to 1000. (TTT)

16833 A COMPUTER PROGRAM FOR DIFFERENTIAL NEUTRON FLUX CALCULATION. Leonard B. Gardner and Nathan F. Shoemaker (Naval Civil Engineering Lab., Port Hueneme, Calif.). 34p. (CONF-641009-4)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A computer program is described for the calculation of differential neutron flux spectra in the high-energy region. This program uses as input data the saturated specific activity of threshold foil detectors, the cross section as a function of energy for the foil's primary reaction, and a first guess of the incident neutron flux spectrum. The program is an iterative type not depending upon the assumption of any particular spectrum shape. Output data consist of the differential neutron flux energy spectrum and error statement. Experience has shown that this program converges after a few iterations to within 10 percent of the spectrum given by the last previous iteration. (auth)

16834 APPARATUS FOR PRODUCING NEUTRONS BY COLLISIONS BETWEEN IONS. Robert R. Warnecke and Hubert Leboutet (to Compagnie Generale de Telegraphie

sans Fil). U. S. Patent 3,155,593. Nov. 3, 1964. Priority date Feb. 2, 1959, France.

The apparatus patented for producing an intense and continuous flow of neutrons consists essentially of an evacuated enclosure or vessel, a suitable means for injecting into this enclosure ions of a relatively light-weight element, and means to form these ions into bunches. The bunches are then reflected in such a manner that a continuous to and fro movement is produced, and periodic encounters between bunches moving in opposite directions are established. Means are provided for the escape of neutrons produced by the impacts between ion bunches. (A.G.W.)

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Refer also to abstracts 15332, 15347, 15348, 15672, 15900, 15926, 15929, 16401, 16820, and 17233.

16835 (AEET/NP/9) ANISOTROPY AND ASYMMETRY IN THE FISSION OF U-235 INDUCED BY 4-Mev NEUTRONS. S. S. Kapoor, D. M. Nadkarni, R. Ramanna, and P. N. Rama Rao (Atomic Energy Establishment, Trombay (India)). 1964. 19p. Dep.(mn).

The correlation between the angular anisotropy and the mass asymmetry of the fragments is determined in the fission of ^{235}U induced by 4 Mev neutrons. The kinetic energies of the pair fragments emitted parallel and perpendicular to the incident beam direction are measured by a three-dimensional analog-to-digital converter incorporated with the print-out arrangement. The anisotropy is found to increase with the asymmetry in the region of mass ratios 1.2 to 1.7. The observed variation of the total kinetic energy and the mean square deviation are found to be different from that observed in the case of thermal fission. The various possibilities leading to the observed dependence of the anisotropy on the asymmetry are discussed. (auth)

16836 (ANL-6900(p.330-4)) NUCLEAR CONSTANTS. Donald C. Stupegia (Argonne National Lab., Ill.).

Preparations are being made for irradiations of U and Pu isotopes in EBR-II to measure the ratio of capture and fission cross sections as a function of position in the reactor. A new program has begun for the measurement of inelastic scattering cross sections as a function of neutron energy. Spectra were obtained for the gamma rays associated with neutron inelastic scattering in Zr, Ho, Nb, Cu, and Re. Neutron cross sections of various reactor materials are being studied as a function of neutron energy in the range occurring in fast reactors. Radiative capture cross sections are reported for ^{185}Re and ^{187}Re for neutron energies between 4 kev and 2 Mev. (auth)

16837 (ANL-6900(p.335-40)) ANALYTICAL RESEARCH AND DEVELOPMENT. R. P. Larsen (Argonne National Lab., Ill.).

A program for the development of methods for determination of burnup on EBR-II fuel is being carried out. The fission product nuclides ^{99}Tc (2×10^5 year) and ^{139}La (stable) were selected as the fission monitors. ^{99}Tc will be determined spectrophotometrically after separation from the fissium constituents and other fission products by the distillation of technetium septoxide from concentrated H_2SO_4. The ^{235}U fast fission yield of ^{99}Tc was determined. The investigation of ^{99}La as a burnup monitor is being carried out by the Idaho Division. The ^{235}U thermal fission yields of ^{99}Tc, ^{133}Cs, and ^{137}Cs were also determined. Values of 6.07 ± 0.08, 6.75 ± 0.07, and 6.32 ± 0.04%, respectively, were obtained. (auth)

16838 (BAW-3125-3) NONUNIFORM TEMPERATURE EFFECTS ON THORIUM RESONANCE ABSORPTION. Quarterly Progress Report No. 3, October 1–December 31, 1964. W. G. Pettus and M. N. Baldwin (Babcock and Wilcox Co., Lynchburg, Va. Critical Experiment Lab.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3125. 17p. (EURAEC-1328). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Described are the activities of an experimental investigation of the effects of nonuniform temperature distributions on the resonance capture integrals of thorium metal and oxide rods. The activation technique exposes samples having different radial temperature gradients in a cadmium thimble at the center of the Lynchburg Pool Reactor. The counting samples are dissolved, and the separated Pa-233 is gamma-counted to obtain the relative integral neutron capture rates. The activations of the oxide series are completed. These include a set of 13 nonuniform temperature measurements having radial temperature drops up to 1000°C and a comparable set of 8 uniform temperature measurements from room temperature to 350°C. In the metal series, 8 activations of the nonuniform temperature sequence are completed. Further activations of the metal series are in progress, as are chemical processing, counting, and data analysis of both the oxide and metal samples. (auth)

16839 (GA-5884) NEUTRON CROSS SECTIONS FOR ALUMINUM. G. D. Joanou and C. A. Stevens (General Atomic, San Diego, Calif.). Nov. 13, 1964. Contract SNPC-27. 68p. (NASA-CR-54260).

A set of neutron cross sections was prepared for aluminum in the energy range from 0.001 ev to 15 Mev. These data are based on existing experimental data, and gaps in existing data were filled by theoretical calculations and in some cases by educated guesses. The reactions included (m,2n), (n,p), (n,np), (n,d), (n,t), (n,He-3), (n,α), and (n,nα). Resonance parameters are also tabulated. (C.E.S.)

16840 (IDO-17050) GAMMA-RAY SPECTROMETRY OF NEUTRON-DEFICIENT ISOTOPES. R. L. Heath and J. E. Cline (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1964. Contract AT(10-1)-205. 67p. Dep.; $3.00(cy), 2(mn) CFSTI.

Studies of neutron-deficient isotopes using gamma spectrometry are presented. A set of pulse-height spectra is sought, which should be representative of the response of a standard gamma scintillation spectrometer to radiations emitted in the decay of neutron-deficient nuclides. These spectra are subsequently processed and included in the Scintillation Spectrometry Gamma-ray Spectrum Catalogue. The production of over 200 neutron-deficient isotopes by gamma-ray and proton induced reactions on a linear electron accelerator and a cyclotron is described. Spectra of over 40 individual isotopes are presented in final form. The results of preliminary investigations of the application of lithium-ion-drifted germanium semiconductor detectors to gamma spectrometry are also presented. Emphasis during this fiscal year has been on the investigation of short-lived isotopes. Using a fast pneumatic shuttle system, nuclides with half lives less than one second have been observed. (auth)

16841 (IEA-75) NEUTRON CROSS SECTIONS OF PRASEODYMIUM, YTTERBIUM AND LUTETIUM. R. Zimmerman, O. Martins, M. Abreu, and M. C. Mattos (Instituto de Energia Atômica, São Paulo, (Brazil)). Nov. 1964. 35p. (CONF-620401-1). Dep.(mn).

From 4th Inter-American Symposium on the Peaceful Application of Nuclear Energy, Mexico City, N. Mex.

The total neutron cross sections of oxides of praseodymium ytterbium, and lutetium have been measured within the neutron energy range from 0.015 to 0.3 electron volts, special attention having been given to obtain values at the thermal energy 0.025 ev. For these measurements, a crystal neutron monochromator with natural calcite crystals was used at the IEA reactor. The purity of the praseosymium, which is most sensitive to high-cross-section impurities, was checked experimentally by measuring the cross section of the sample before and after a purification process that reduces the gadolinium concentration by a factor greater than 100. The consistency of the results indicates that the sample used in these experiments contains a negligible amount of gadolinium and samarium. The correction to the cross sections due to the presence of second order reflec-

tion from the monochromator crystal was made experimentally by measuring the gold cross section in an appropriate energy interval. In one of the elements, lutetium, a nuclear resonance exists within the energy range studied. Calculations with the Breit-Wigner formula for this resonance in lutetium, and for the cross section of praseodymium, show that no nearby bound state is necessary to explain the magnitude and shape of the experimental results. Evidence of a bound state exists in the case of ytterbium. (auth)

16842 (IFA-MC-7) SUR LES DISTRIBUTIONS D'ÉQUILIBRE EN THEORIE DU POTENTIEL. (On the Equilibrium Distributions in the Theory of Potential). Ion Zamfirescu (Institutul de Fizică Atomică, Academia R. P. R., Bucharest (Romania)). 1964. 10p. Dep.(mn).

The results calculated on the equilibrium distributions on K for a family of repulsive nuclei are reported. (J.S.R.)

16843 (IITRI-578P24-12) STUDIES OF THE RESONANCE INTEGRALS OF Re AND Tm. Final Report, March 15, 1963–March 14, 1964. G. Hardie, D. A. Klopp, W. E. Loewe, and W. E. Zagotta (IIT Research Inst., Chicago, Ill.). Sept. 30, 1964. Contract AT(11-1)-578. 123p. Dep., $4.00(cy), 3(mn) CFSTI.

An analysis was performed to measure the resonance integral of thulium by activation and reactivity techniques, to calculate the effect of crystalline binding on the infinitely dilute resonance integral of rhenium, and to measure the sensitivity of the IITRI Reactor for danger coefficient measurements. The quasi-absolute counting technique yielded 1110 ± 130 barns, the cadmium ratio yielded 2210 ± 160 barns, and the danger coefficient yielded 1790 ± 200 barns for the Tm resonance integral. An additional value of 1600 ± 500 barns was obtained by calculation using the resonance parameters. It is concluded that this package of measurements has evinced errors that are probably systematic errors. The crystalline binding calculations by the method of Nelkin and Parks showed no significant effect on the infinitely dilute resonance integral of rhenium. Further study showed that the effective temperature formalism predicts these negative results. This study also shows that significant crystalline binding effects are expected only for highly self-shielded resonance absorbers. The measurements of the sensitivity of the IITRI Reactor showed that at the present it is about 4×10^{-2} barns per nucleus of a one mole sample. This is believed to be adequate for most resonance integral measurements. (auth)

16844 (ISS-64/36) A DESCRIPTION OF A ROUGH COMPUTATION OF THE SEPARATION ENERGY OF STRONGLY BOUND NUCLEONS. D. M. Brink and N. Sherman (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Nov. 12, 1964. 37p. Dep.(mn).

The details of a rough but reasonable estimate of the adiabatic separation energies of nucleons ejected from the 1s shells of nuclei between ^{7}Li and ^{40}Ca are reported. The general assumptions and specific approximations are listed explicitly. The general expression for the energy is successively simplified using the approximations assumed. The calculational tricks used to compute matrix elements are described in detail, and the results for the 1s shell are listed for reference. (auth)

16845 (LA-3169) A METHOD FOR ESTIMATING FRACTIONAL YIELDS FROM LOW-AND MEDIUM-ENERGY NEUTRON-INDUCED FISSION. Kurt Wolfsberg (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 1964. Contract W-7405-eng-36. 26p. Dep.; $2.00 (cy), 1(mn) CFSTI.

A method is given for estimating fractional yields of products from low- and medium-energy neutron-induced fission. The method is based on experimental measurements of some fractional independent and cumulative yields, and involves the assumption that yields of products along beta-decay chains are described by a Gaussian function with the same width for all mass numbers. Equations are given for estimating Z_p, "the most probable charge." Fractional yields may be obtained from a table that lists fractional yields as a function of $Z - Z_p$. (auth)

16846 (LA-DC-6666) SIMULTANEOUS VELOCITY AND ENERGY MEASUREMENT OF FISSION FRAGMENTS. William E. Stein (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract [W-7405-eng-36]. 19p. (CONF-650301-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

Semiconductor detectors were used in a double-velocity apparatus for a simultaneous measurement of fragment velocities and detector pulse heights. The purposes of this measurement were to obtain the pulse-height to energy calibration of these detectors for fission fragments and to evaluate a technique for the simultaneous determination of pre- and post-neutron emission parameters of the fission process from a coincident measurement of fragment velocities and energies. Fast and slow output signals were obtained from the detectors for use in the time-of-flight and pulse height measurements, respectively. The recorded data were the flight times of both fragments and the pulse height from one of the detectors for a total of 46,000 ^{252}Cf fission events. Fragment velocities, initial masses, and initial energies were obtained in the usual manner from the time-of-flight data. The detector calibration function was determined from the correlation between the recorded pulse heights and the final parameters of the corresponding fragments. The latter values were obtained from the initial mass, initial energy and the published values of $\bar{\nu}(M,E_K)$ for californium fragments. Finally the calibration function was corrected for instrumental dispersions and the dependence of the average energy on fragment mass. The post-neutron-emission parameters were obtained from the recorded data and available detector calibration procedures including the one given above. The average number of neutrons emitted as a function of fragment mass was obtained from the event-by-event differences of the initial and final masses. This result provided a sensitive test of the validity of this proposed technique and the various calibration procedures. Agreement with published data was found for the calibration procedure based on these data and one derived from the response of semiconductor detectors to accelerated bromine and iodine ions. In each case the root-mean-square deviation from the published values of $\bar{\nu}$ was less than 0.7 of a neutron. (auth)

16847 (LAL-1069) ETUDE DE NIVEAUX EXCITES DU BERYLLIUM 9 ET DU CALCIUM 40 PAR DIFFUSION INELASTIQUE D'ELECTRONS (THESE). (Study of Excited Levels of Beryllium-9 and of Calcium-40 by Inelastic Scattering of Electrons (thesis)). M. Hors (Laboratoire de l'Accelérateur Linéaire, Univ. de Paris, Orsay (France)). 1963. 98p. Dep.(mn).

The inelastic scattering of electrons on ^{9}Be and ^{40}Ca was studied. The methods used for the analysis of the experimental data and the experimental apparatus are described in detail. Three levels of ^{9}Be at 1.6, 2.47, and 6.4 Mev were studied. It was shown that the parity of the level at 2.4 Mev is negative, that the spin and parity of the level at 6.4 Mev are $\frac{7}{2}^-$, and that these two levels are members of a rotational band with $K = \frac{3}{2}^-$ based on the non-excited state. The radiation lengths and the probabilities of reduced transition were determined for these two levels and for the level at 1.6 Mev. The isotope ^{40}Ca was studied precisely for excitation energies between 10 and 15 Mev. Five levels were detected with four-momentum transfers going from 0.5 to 1.4 f^{-1}. (J.S.R.)

16848 (MIT-905-30) THE ENERGY BALANCE IN FISSION AND MONTE CARLO CALCULATIONS ON PROMPT-NEUTRON EMISSION. G. E. Gordon and N. K. Aras (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry and Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [1964]. Contract AT(30-1)-905. 34p. (CONF-650305-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Conference on Physics and Chemistry of Fission, Vienna.

The evaporation of neutrons from primary fission fragments was treated by the Monte Carlo method. The total

energy release E_T for fission of $^{236*}U$ into a given pair of complementary, primary fragments is obtained from semi-empirical mass formulas. The average kinetic energy, $\bar{E}_K$, for a given mass ratio of division is obtained from the results of instrumental studies with the average sum of the fragment excitation energies, $\bar{E}_x$, being given by $E_T - \bar{E}_K$. The division of $\bar{E}_x$ between light and heavy complementary fragments is determined by a completely free parameter. The latter is adjusted to yield the experimental ratio of average number of prompt neutrons emitted by the light fragment, $\bar{\nu}_L$ to that of the heavy fragment, $\bar{\nu}_H$. Dispersion of the excitation energies is determined by dispersion in kinetic energies. Primary mass yields are taken from instrumental fission studies. Charge distribution is assumed Gaussian (with $\sigma = 0.62$) about the most-probable value, Z_p for each mass. The latter is adjusted to give agreement with experimental results. Nuclear level densities are assumed proportional to $\exp[2a^{1/2}(E-\delta)^{1/2}]$, with $a = A/13$; δ is a correction for odd-even effects. Monte Carlo iterations are performed by a computer for all primary fragments of appreciable yield. Good agreement was obtained with several important experimental quantities: the dependence of $\bar{\nu}_A$ upon mass number, the neutron kinetic energy spectrum, and the average prompt γ-ray energy release. In regions of large $\bar{\nu}_A$ the secondary charge-distribution curves are much broader than for the primary fragments and sometimes asymmetric, with the low-Z side broader than the high-Z side. Dispersions in ν's are so large as to suggest that the assumption that $\bar{E}_K$ is the same for all charge divisions for a given mass division must be relaxed to obtain agreement with experimental data. (auth)

16849 (MLM-1163(p.0-1-3)) THE OCCURRENCE OF (n,2n) AND (n,3n) REACTIONS IN A THERMAL REACTOR. R. C. Lange (Mound Lab., Miamisburg, Ohio).

A search was made for the presence and origin of ^{208}Po and ^{209}Po in reactor-produced ^{210}Po. The initial atom ratio ($^{209}Po/^{208}Po$) was found to fall in the range 2.9 to 1.4×10^3, as compared to the value 1.5×10^3 predicted from the assumption that these isotopes are produced by (n,2n) and (n,3n) reactions of ^{210}Po. (D.L.C.)

16850 (NAA-SR-Memo-8889) NAA PROGRAM DESCRIPTION. ARES-II. A RESONANCE INTEGRAL CODE. F. L. Fillmore and B. D. O'Reilly (Atomics International, Canoga Park, Calif.). Revised July 1963. Contract AT(11-1)-Gen-8. 43p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The ARES code is used to calculate effective resonance integrals and multigroup cross sections for lumps and mixtures using resonance parameters. ARES II is a revision of the ARES I code which was described in AMTD-130 A (October, 1962). The instructions for using the code were not changed, but their description was amplified, and a flow chart of the main program was included. The results of calculations of the effective resonance integrals of uranium, thorium, and UO_2 are presented and comparison made with experimental measurements. (auth)

16851 (NAA-SR-Memo-10544) MAG—A PROGRAM TO PREPARE FAST GROUP CROSS SECTIONS IN THE DTF FORMAT. R. S. Hubner (Atomics International, Canoga Park, Calif.). Nov. 6, 1964. Contract AT-11-1-GEN-8. 45p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Program MAG is described. It punches in the DTF FORMAT any fast group cross section library in which the absorption, times the fission, total, transport, removal, and scatter cross sections, and the P0, P1, P2, and (n,2n) transfer matrices are supplied. The maximum number of fast groups is 28. Cross sections excluding transfer matrices must also be supplied in the input for two thermal groups and are punched in the DTF FORMAT along with the fast group cross sections. Two sets of cross sections are punched for each isotope processed. (auth)

16852 (NP-14647) ANNUAL REPORT, APRIL 1963–MARCH 1964. (Tokyo Univ. (Japan). Inst. for Nuclear Study). May 1, 1964. 78p. Dep.(mn).

The experimental facilities available for use in low-energy physics research are described, and experiments with a synchrocyclotron are reported. An evaluation of proposals for long-range low-energy physics research is included. The experimental facilities available for use in high-energy physics research are described, and experiments with an electron synchrotron are reported. Measurements on cosmic air showers are reported, and data on cosmic radiation obtained in balloon flights are analyzed. Research on theoretical physics is reported along with activities at the chemical laboratory. (J.R.D.)

16853 (NP-14687) VYKHODY FLUORESTSENTSII DLYA L-OBOLOCHKI NEPTUNIYA I PLUTONIYA. (Fluorescence Yields for the L Shell of Neptunium and Plutonium). G. G. Akalaev, N. A. Vartanov, and P. S. Samilov (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 7p. Dep.(mn).

Mean fluorescence yields were determined for the radioactive decay of ^{241}Am, ^{242}Cm, and ^{244}Cm. The fluorescence and Auger yields for Np and Pu L_1, L_2, and L_3 subshells were found. (R.V.J.)

16854 (NP-14792) OFF ENERGY SHELL PARTICLE PROPAGATORS IN THE BRUECKNER THEORY. J. L. Gammel and J. Nuttall (Texas Agricultural and Mechanical Univ., College Station). [1963]. 12p.

The treatment of off energy shell particle propagation in Brueckner and Gammel's Appendix A (Phys. Rev. 109, 1023 (1958)) is inexact in sixth and higher orders. The relevant graphs in sixth order are calculated, and the results show that their equations provide an excellent approximation. (auth)

16855 (ORNL-3714(Vol.I)(p.1-30)) · NUCLEAR AND REACTOR PHYSICS. (Oak Ridge National Lab., Tenn.).

Research summaries are presented on scattering of 11-Mev protons from medium-weight nuclei, distorted wave analysis of the $^{90}Zr(d,p)^{91}Zr$ reaction, wide angle scattering of 43-Mev alpha particles by ^{58}Ni, nomograms for low-energy nuclear reactions, elastic scattering parameters in (d,p) stripping, optical model parameters for $^{90}Zr(d,p)^{91}Zr$ below 4 Mev, testing techniques for control rod effectiveness theories, extension of Weinberg's theorem to non-homogeneous nuclear systems, cross sections for $^{9}Be(\alpha,n)$ reactions at 6 to 10 Mev, photoneutron spectra from ^{16}O, ^{12}C, and ^{27}Al, spectra of bremsstrahlung-produced neutrons from ^{206}Pb, ^{208}Pb, and ^{209}Bi, polarization of deuterons in the $^{9}Be(p,d)^{8}Be$ reaction at 3 to 5 Mev, variation of ^{235}U capture and fission cross section ratios, slow neutron fission cross sections of ^{239}Pu, and measurements of the temperature dependence of neutron diffusion parameters in ice (H_2O). References to publications in which the research is described are included. (J.R.D.)

16856 (ORNL-P-788) PARTICLES EMITTED IN THE FORWARD DIRECTION FROM HIGH-ENERGY NUCLEON-NUCLEUS KNOCK-ON REACTIONS. H. W. Bertini (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 16p. (CONF-720-6). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Energy and angular distributions of emitted secondaries from nucleon-nucleus reactions are obtained from an intranuclear cascade calculation. The main assumption in this calculation is that high energy (~100 Mev) nucleon-nucleus reactions occur via a series of individual particle-particle reactions within the nucleus where the differential cross sections used in determining the scattering angles in the particle-particle reactions are the free-particle differential scattering cross sections. Examples of the shapes of the curves for the n-p and p-p free-particle differential cross sections plotted vs the laboratory scattering angle for energies of 40 and 160 Mev are illustrated. Results for (p,n) and (p,p) reactions with cobalt are also presented. (C.E.S.)

16857 (P-996(RAND)) ON THE PRINCIPLE OF INVARIANT IMBEDDING AND ONE-DIMENSIONAL NEU-

TRON MULTIPLICATION. Richard Bellman, Robert Kalaba (RAND Corp., Santa Monica, Calif.); and G. Milton Wing (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 19, 1956. 10p. (AD-605127). $1.00 (CFSTI).

A new method is introduced for treating problems involving neutron multiplication by fission, with special regard to questions of critical mass and distribution of neutrons. The results derive from applications of the principle of invariant imbedding, which was introduced and discussed previously. (auth)

16858 (UCRL-11535) OPTIMUM MULTIPLE SCATTERING. Douglas E. Greiner (Lawrence Radiation Lab., Univ. of California, Berkeley). June 1964. Contract W-7405-eng-48. 8p. (CONF-787-4). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From 5th International Conference on Nuclear Photography, Geneva, Sept. 1964.

An attempt was made to study the best utilization of multiple scattering data to determine the scattering rigidity of a particle. (C.E.S.)

16859 (USNRDL-TR-802) BETA SPECTRA. II. SPECTRA OF INDIVIDUAL NEGATRON EMITTERS. O. H. Hogan, P. E. Zigman, and J. L. Mackin (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 16, 1964. Contract AT-49-2505(1). 220p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Beta spectra for 397 β^--emitters were computed at 200 points from the Fermi theory of beta decay using a correction factor for unique-forbidden transitions. These spectra, after normalization and plotting versus energy, are presented, along with experimental end-point energies, forbiddenness assignments, and half lives. (auth)

16860 DECAY OF CESIUM-137 DETERMINED BY ABSOLUTE COUNTING METHODS. Janet S. Merritt and J. G. V. Taylor (Atomic Energy of Canada Ltd., Chalk River, Ont.). Anal. Chem., 37: 351-4(Mar. 1965).

Precise decay data for ^{137}Cs were determined by absolute counting techniques aided by a rapid method for the carrier-free separation of ^{137m}Ba. The following values for the decay parameters were obtained: half life of ^{137m}Ba, 2.554 ± 0.003 minutes; total internal conversion coefficient of the 662-kev transition, 0.1100 ± 0.0011; K-conversion coefficient, 0.0894 ± 0.0010; branching ratio for the decay of ^{137}Cs to ^{137m}Ba, 0.952 ± 0.010; ratio of 662 kev γ emission to ^{137}Cs distintegration rate, 0.857 ± 0.009. The relative uncertainty of ~ ± 1% obtained for the latter ratio should make possible the absolute assay of ^{137}Cs by γ spectrometry to ±2% or better. (auth)

16861 ON THE EFFECTIVE NUCLEON-NUCLEON INTERACTION ON THE FERMI SURFACE OF FINITE NUCLEI. Alpo Kallio (Nordisk Institut För Teoretisk Atomfysik, Copenhagen). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 163, 1-35(1964).

A survey of methods for calculation of the effective interaction of nucleons inside the nucleus is given, with special emphasis on the region close to Fermi surface. The separation method of Moszkowski and Scott is applied to calculate the spectrum of ^{16}O. It is also shown that the long range part of the free N-N force is responsible for pairing in heavy nuclei. There is some evidence that the second-order tensor contribution is responsible for the long-range effective force in addition to the short-range pairing force. An interesting connection between the level ordering of one-particle states and the fraction of singlet S-state probability for the corresponding two-particle wave function is established. (auth)

16862 AN EXPERIMENTAL INVESTIGATION OF THE ALPHA FINE STRUCTURE IN Ac-225, Fr-221, At-217, AND Po-213. Kalevi Valli (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 165, 1-42(1964).

The alpha fine structure of ^{225}Ac, ^{221}Fr, ^{217}At, and ^{213}Po was investigated by means of alpha-gamma coincidence spectroscopy with semiconductor detectors, an ionization chamber, and sodium iodide scintillation detectors. Fifteen alpha peaks were observed in ^{225}Ac, four of which have not been reported before. One peak previously assigned to ^{225}Ac was found to belong to ^{213}Bi. Eight peaks were observed in ^{221}Fr, six of them previously unreported. Three new peaks were observed in ^{217}At and one in ^{213}Po. The modes of decay of the excited states populated by the alpha decay were investigated. Level schemes were constructed for ^{221}Fr, ^{217}At, and ^{213}Bi. Upper limits for beta branching in ^{217}At and ^{213}Po were determined. (auth)

16863 DYNAMIC ORIENTATION OF SPIN 1 NUCLEI. PART I. K. L. Bhatia and M. L. Narchal (Kurukshetra Univ., India). Appl. Opt., 4: 175-80(Feb. 1965).

The Overhauser effect in an electron-nuclear coupled spin system ($S = \frac{1}{2}$, $I = 1$) was studied in detail. From a population distribution analysis of the system, the nuclear orientation parameters were computed, and their temperature dependence is discussed. Conditions for achieving stimulated emission were examined. (auth)

16864 A PRECISION MEASUREMENT OF $(\alpha_2)_K$ OF THE 412 kev TRANSITION IN Hg^{198} BY THE INTERNAL-EXTERNAL CONVERSION METHOD AND A HIGH RESOLUTION STUDY OF THE 412 kev ANGULAR DISTRIBUTION OF GOLD K-SHELL PHOTOELECTRONS. Karl-Erik Bergkvist and Soelve Hultberg (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 27: 321-38(1965).

A precision measurement, using the internal-external conversion method, is reported for the K internal conversion coefficient of the 412-kev E2 transition in ^{198}Hg, following the decay of ^{198}Au. The value found is 0.0302 ± 0.0004, which is in agreement with theory (0.0300). Nominal resolution was 0.15% for both internal and external conversion measurements. Converters of 0.1 mg/cm^2 were used. Also reported is a careful study, in the angular interval $20° \leq \theta \leq 90°$, of the K photoelectric angular function at $h\nu = 412$ kev. Good agreement was found with theoretical calculations of Hultberg, Nagel, and Olsson. The measurements were carried out using the high-luminosity, high-resolution techniques as introduced by Bergkvist. (auth)

16865 ON THE M4 ISOMERISM IN Pb^{205}. K.-E. Bergkvist and R. Stockendal (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 27: 339-49(1965).

From measurements at about 0.05% resolution in a high-luminosity, high-resolution electrostatic-magnetic beta spectrometer, it was established that there are two transitions in ^{205}Pb having almost the same energy (1013.8 and 1014.4 kev). The transition of lower energy was identified as the isomeric $i_{13/2} \rightarrow f_{5/2}$ transition. The large discrepancy earlier found between the matrix element of the M4 transition in ^{205}Pb and those of other odd-mass Pb isotopes is thereby considerably diminished. Still, however, the experimental results indicate a matrix element higher than expected from the systematics. (auth)

16866 A METHOD FOR THE REDUCTION OF THE COMPTON BACKGROUND OF EXTERNAL CONVERSION MEASUREMENTS. Karl-Erik Bergkvist (Nobel Inst. of Physics, Stockholm). Arkiv. Fysik, 27: 351-72(1965).

A method for the reduction of the Compton background generally accompanying the photoline spectrum of external conversion measurements and originating in the absorber between the γ-source and converter is given and studied theoretically and experimentally with regard to its basic, inherent properties. The reduction of this background type, which is generally the most disturbing one, is achieved by a suitable geometric separation of the position of the Compton event in the absorber and the photo process in the converter, combined with a simultaneous partial blocking off of the detector slit, a flat, double focusing type of beta-spectrometer being best suited for the energy analysis of the photoelectrons. The possible background reduction factor is higher the thinner the converter is, which means that the method becomes particularly useful at high resolution. At the same time an extended converter is re-

quired; an adaptation to high luminosity methods, allowing the use of a large converter in connection with high resolution, is therefore included. (auth)

16867 MEASUREMENTS OF PHOTONEUTRON YIELD FROM THICK COPPER AND WATER TARGETS AND DETERMINATION OF EXCITATION FUNCTIONS FOR ^{16}O AND $^{63}Cu(\gamma,n)$ REACTIONS BY MEANS OF BELENKII-TAMM EQUILIBRATE PHOTON SPECTRA. I. A. Grishaev, D. I. Sikora, V. A. Shkoda-Ul'yanov, and B. M. Shramenko. At. Energ. (USSR), 18: 28-33(Jan. 1965). (In Russian)

The yield of photoneutrons from infinitely thick copper and water targets irradiated by 66-Mev electrons was estimated. The obtained data and the Belenkii-Tamm theory were used for calculating excitation functions of (γ,n)-reactions for ^{16}O and ^{63}Cu. The results were correlated with the data previously obtained with thin specimens irradiated by bremsstrahlung γ quanta. (tr-auth)

16868 NOMOGRAMS FOR DETERMINING THE HEIGHT OF POTENTIAL BARRIER AND FOR BREIT-WIGNER FORMULA. G. N. Potetyunko. At. Energ. (USSR), 18: 61-2(Jan. 1965). (In Russian)

Equations were developed for two nomogram elements (the scale and the binary fields) in order to determine the potential barriers and for the Breit-Wigner formula. The method of aligned points was used for the first nomogram, and the principle of superimposition was used for the second nomogram. (R.V.J.)

16869 ANGULAR DISTRIBUTION OF GAMMA QUANTA FROM ^{233}U, ^{235}U, AND ^{239}Pu FISSION BY THERMAL NEUTRONS. G. A. Petrov, D. M. Kaminker, G. V. Val'skii, and L. A. Popeko. At. Energ. (USSR), 18: 64-5(Jan. 1965). (In Russian)

Angular correlations of fission products and γ rays from ^{233}U, ^{235}U, and ^{239}Pu fission by thermal neutrons were measured. The recording and spectrometry of fission products were carried out with 0.25, 0.5, and 1 cm^3 p-n type semiconductor detectors. The γ rays were measured with FEU-13 and FEU-33 photomultipliers with a NaI(Tl) crystal 60 mm in height and diameter. The γ-ray and fission product correlations were measured with a multichannel experimental installation with a fast-slow coincidence scheme. The fast 100 kev γ quantum coincidences and fission product pulses were measured over three angles. The angular distribution of γ radiation from ^{233}U and ^{239}Pu fission and the anisotropic dependence on γ quanta were measured in a single-channel installation. The results showed that the magnitudes of ^{233}U, ^{235}U, and ^{239}Pu anisotropy are almost identical, with a slightly larger γ quantum anisotropy for ^{239}Pu. The magnitude of anisotropy, within the experimental order of error, does not vary at γ-quantum energies from 100 to 500 kev. (R.V.J.)

16870 DETERMINATION OF THE ABSOLUTE YIELD OF ^{239}U 74-kev AND ^{233}Th 87-kev GAMMA LINES. L. N. Yurova and A. V. Bushuev. At. Energ. (USSR), 18: 65-7 (Jan. 1965). (In Russian)

The absolute yields for the ^{239}U 74-kev and ^{233}Th 87-kev γ lines were determined by measuring ^{197}Au and ^{238}U or ^{197}Au and ^{232}Th specimens irradiated simultaneously in a thermal reactor. The γ spectra of irradiated specimens were investigated using a scintillation spectrometer with a NaI(Tl) crystal and a 100-channel pulse-height analyzer. The γ-line intensities and yields were calculated by measuring the areas under the photopeaks. The ratios of the intensities of the ^{239}U 74-kev line, the ^{198}Au 72-kev line, and for ^{233}Th 87-kev line and the data on absolute yield of ^{198}Au 72-kev line were used to determine the absolute yield for ^{239}U 74-kev line, which was 43.5 ± 3.0% and for the ^{233}Th 87-kev line, which was 2.9 ± 0.2%. (R.V.J.)

16871 SINGLE SCATTERING OF NEGATIVE MUONS OF 8 Bev/c IN NUCLEAR EMULSIONS. C. Castagnoli, A. Longhetto, A. Wataghin, C. Lamborizio, and I. Ortalli. Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 36: 355-60(Mar. 1964). (In Italian)

The results on the measurement of scattering in nuclear emulsions of μ^- at 8 Bev/c were reported and compared with the results obtained previously. The experimental method was described in some detail. The results favored the theory of the point nucleus or the theory of the extended nucleus to which is added contributions of abnormal scattering. (J.S.R.)

16872 STUDIES ON THE RANGE OF ^{140}Ba IN PROTON-INDUCED FISSION OF ^{238}U AND A SEMI-EMPIRICAL DERIVATION OF A GENERAL RANGE-ENERGY RELATION. S. Mukherji and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 43: 232-48(Jan. 1965).

Ranges of ^{140}Ba were measured in the forward and backward directions with respect to the proton beam by bombarding uranium foils of normal isotopic composition with protons of 15, 30, and 60 Mev energies. Successive thin layers of aluminium were removed from the front and back catchers by an electrochemical technique, and the ranges were calculated from the relative distribution of ^{140}Ba activity in the different layers. The calculations indicate that full momentum transfer of the incident protons has taken place, suggesting that the compound nucleus mechanism is predominant at these energies. An analysis of the existing range and energy data for fission fragments showed that the effective charge of a fission fragment, first postulated by Bohr, can be expressed as a function of the charge and the mass of the medium being penetrated. The original range-velocity relation of Bohr was modified to include the above fact and has led to a general range-velocity relation for ranges in different metallic catchers. Similar equations seem to be applicable to the range data in gaseous media. (auth)

16873 MASS DISTRIBUTION IN THERMAL NEUTRON FISSION OF ^{239}Pu. D. A. Marsden and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 43: 249-67(Jan. 1965).

Improved radiochemical techniques were used to study the distribution in mass of the fission fragments resulting from thermal neutron fission in ^{239}Pu. Disintegration rates and half lives were determined by measurement with a $4\pi\beta$ gas flow proportional counter. Further identification of the nuclides was obtained by gamma scintillation spectrometry. The flux intensity during irradiation was monitored by the $^{59}Co(n,\gamma)^{60}Co$ reaction. The absolute fission yields of ^{89}Sr, ^{90}Sr, ^{91}Y, ^{95}Zr, ^{99}Mo, ^{103}Ru, ^{106}Ru, ^{105}Rh, ^{109}Pd, ^{112}Pd, ^{111}Ag, and ^{115}Cd in the light mass peak and ^{127}Sb, ^{131}I, ^{133}I, ^{132}Te, ^{137}Cs, ^{140}Ba, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{147}Nd, and ^{156}Eu in the heavy mass peak were measured. In addition, the independent yields of ^{82}Br, ^{124}Sb, ^{126}Sb, and ^{136}Cs were obtained. (auth)

16874 PRECISION MEASUREMENT OF THE MOMENTA OF CONVERSION ELECTRON LINES FROM SOURCES OF ^{212}Pb(ThB). R. L. Graham, G. Murray, and J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 171-92(Feb. 1965).

Momentum ratios of some of the more intense internal conversion lines from sources of thorium radioactive deposit were determined with accuracies of 1 to 4 parts in 10^5 using an iron-free β spectrometer. Accurate absolute values of the momenta were obtained from intercomparisons of these line momenta with that of the K-412 internal conversion line in ^{198}Hg. The x-ray self-calibration method of Siegbahn is discussed in some detail and is shown to be less accurate at this time. The results are analyzed on both the 1955 and 1963 least-squares adjusted values of the fundamental constants. (auth)

16875 PHOTOALPHA REACTIONS IN ^{12}C AND ^{16}O BELOW 17 Mev. Jan P. Roalsvig (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Phys., 43: 330-7(Feb. 1965).

Yield and cross section curves were obtained for the reactions $^{12}C(\gamma,3\alpha)$, $^{16}O(\gamma,4\alpha)$, and $^{16}O(\gamma,\alpha)^{12}C$ from 12 to 17 Mev by irradiating nuclear emulsions in the beam from the University of Saskatchewan betatron. (auth)

16876 γ-RADIATION FROM INTERACTION OF DEUTERONS WITH Li. J. Juna and K. Konecny (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 15: 95-9(1965).

The result of measurements of the energy of γ-radiation

originating during the interaction of deuterons (800 kev) with Li are given, together with an explanation of the origin of the radiation. (auth)

16877 A STUDY OF THE $Co^{59}(p,n)$ REACTION AT E_p = 5.75 TO 6.39 Mev. M. Rozkos, F. Sterba, and J. Sterbova (Technical Univ., Prague). Czech. J. Phys., 15: 151-7(1965).

The angular distribution of neutrons from the reaction $^{59}Co(n,p)^{59}Ni$ was measured for six proton energies E_p lying in an interval between 5.75 and 6.39 Mev. The analysis of these results showed that other mechanisms besides the compound nucleus mechanism play a role in the whole region of E_p studied. Neither their relative contribution nor the exact mechanism were determined. (auth)

16878 STRUCTURE OF EXCITED STATES WITH $K^\pi = 2^+$ EVEN-EVEN DEFORMED NUCLEI. V. G. Solovev. Dokl. Akad. Nauk SSSR, 159: 310-13(Nov. 11, 1964). (In Russian)

The energy of the two lowest states with angular momentum projection on the symmetry axis equal to 2, and with positive parity, of even-even nuclei in the mass-number ranges from 150 to 190 and 228 to 254 is calculated. The properties of these states are investigated with allowance for blocking, and the relation between the collective and two-quasiparticle structure is studied. A unified description is obtained, within the framework of the superfluid model of the nucleus, for the two-quasiparticle and collective nonrotational states of deformed even-even nuclei. It is shown that the average field of the nucleus determines which of the lowest states with K = 2 are collective, and which are two-quasiparticle ones. (ATD)

16879 ON THE SPECTROSCOPY OF GAMMA-ALPHA REACTIONS WITH PHOTONUCLEAR EMULSIONS. F. I. Havlicek and M. Modesto (Nuclear Institute "Jozef Stefan," Ljubljana, Yugoslavia). Energia Nucl. (Milan), 12: 77-84 (Feb. 1965).

To obtain the largest possible number of traces of alpha particles in photonuclear emulsions, investigations were carried out on a procedure by which nearly all that was superfluous was corroded off, so that the traces of the lighter particles were put almost entirely into the background. In order to control the precision of the measurements with the emulsions treated this way, measurements of 14.7-Mev (n,α) reactions already made elsewhere were remade. Reactions (γ,α) with fluoron, aluminum, silicon, and gold were investigated up to 31 Mev, making use of targets of 1.5 to 4 mg/cm^2; finer structures in the spectra were found. (auth)

16880 THE CROSS SECTIONS FOR THE PROTON-INDUCED REACTION ON Cd^{112}. Sanshiro Kume and Asae Mitoh (Osaka Univ.). Genshikaku Kenkyu, 9: 311-22(Aug. 1964). (In Japanese)

The excitation functions of $^{112}Cd(p,n)^{112}In$, $^{112}Cd(p,2n)^{111}In$, and $^{112}Cd(p,3n)^{110}In$ reactions were measured with 55-Mev incident protons. The results were compared with previous data on $^{109}Ag + \alpha$, $^{111}Cd + d$, and $^{112}Cd + p$ reactions. The effect of angular momentum on the excitation functions was not observed and the same value, 2 to 3 Mev^{-1}, for α, the parameter in the formula of the level density, gave a good fit to our experimental results for different incident particles. The isomeric cross section ratios are also discussed. (auth)

16881 INTERNAL-EXTERNAL CONVERSION STUDIES IN THE DECAY OF Eu^{154}. Toshio Katoh (Nagoya Univ., Japan) and W. H. Brantley. Genshikaku Kenkyu, 9: 347-62 (Aug. 1964). (In Japanese)

Internal-external conversion studies were made in an iron-free double focusing beta-ray spectrometer to clarify the decay scheme of ^{154}Eu. A 3.71 mg/cm^2 thick uranium converter was used in the determination of the gamma-ray intensities by the external conversion method. Internal conversion intensities, gamma-ray intensities, conversion coefficients, and transition energies were obtained. The multipolarity assignments of the 693.7, 724.6, 757.9, 999.1, 1007.1, and 1277.9 kev transitions were determined to be E0 + E2, E1, E2, E2, E2, and E1 respectively. The decay scheme is revised. (auth)

16882 RESONANCES IN THE $^{40}Ar(p,\gamma)^{41}K$ REACTION. R. Bloch, R. E. Pixley, H. Staub, F. Waldner, and H. Winkler (Universitat, Zurich). Helv. Phys. Acta, 37: 722-5 (1964).

Two resonances in the $^{40}Ar(p,\gamma)^{41}K$ reaction were investigated using good energy resolution and a differentially pumped gas target. The following resonance energies were measured: 1086 ± 1 and 1101.8 ± 0.3 kev. Gamma spectra were obtained for both resonances and the partial widths of several transitions were determined. (auth)

16883 SPIN ASSIGNMENT FOR THE 268 kev LEVEL OF Au^{197}. N. C. Singhal and P. N. Trehan (Panjab Univ., Chandigarh, India). Indian J. Pure Appl. Phys., 3: 36-7 (Jan. 1965).

The theoretical cross sections for the inelastic scattering of neutrons from the 268-kev level of ^{197}Au for two different spin-parity assignments, viz. $\frac{1}{2}^+$ and $\frac{3}{2}^+$, were obtained using the Hauser and Feshbach method, and compared with the experimentally measured values obtained from the ^{197}Au $(n,n'\gamma)$ reaction. The results indicated that the $\frac{3}{2}^+$ assignment is the most probable value for this level. (auth)

16884 ELECTROMAGNETIC EXCITATION OF A NUCLEUS BY A SLOW PARTICLE WITH ARBITRARY SPIN. V. A. Dzhrbashyan (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 17: No. 5, 99-101(1964). (In Russian)

Formulas are derived for the cross sections of multipole and magnetic spin and magnetic orbit interactions. The cross section for the magnetic spin interaction agrees with the results of Biederhahn and Thaler (Phys. Rev. 104: 1643 (1956)) for $s = \frac{1}{2}$ and $\lambda = 1$. It is pointed out that for $s > \frac{1}{2}$ (for example, excitation by deuterons) the M1 excitation cross section is governed almost completely by the ratio of the two derived cross sections. (ATD)

16885 MATERIALY XIV EZHEGODNOGO SOVESHCHANIYA PO YADERNOI SPEKTROSKOPII (TBILISI, 14-22 FEVRALYA 1964 G.). (Reports of the 14th Annual Conference on Nuclear Spectroscopy, Tbilisi, USSR, February 14-22, 1964). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1550-1728 (Oct. 1964). (CONF-640205)

Separate abstracts were prepared for the twenty papers included. (D.C.W.)

For abstracts of individual papers see: 15886, 16266, 16342, 16886, 16887, 16888, 16889, 16890, 16891, 16892, 16893, 16894, 16895, 16896, 16897, 16898, 16899, 16900, 16901, and 16902.

16886 NUCLEON CLUSTERS IN LIGHT NUCLEI. V. I. Mamasakhlisov (Tbilisi State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1550-72(Oct. 1964). (In Russian)

A review is presented of recent experimental and theoretical research on nucleon clustering in light nuclei. The concept of clustering is first defined. It is pointed out that clustering is favored by low density of nuclear matter and can, accordingly, be expected to occur in light nuclei and in the peripheral regions of heavy nuclei. Recent evidence for clustering is then reviewed, including alpha particle yields from 40- to 600-Mev proton bombardment; relative yields of heavy particles and nucleons; angular correlation in $(\alpha,2\alpha)$ reactions; π^- capture with expulsion of fast deuterons or tritons; the structure of the giant photodisintegration resonance; photodisintegration resonances in light nuclei; the $^9Be(\alpha,3\alpha n)$ and $^{12}C(\alpha,4\alpha)$ reactions; the $^6Li(p,pd)$, $^6Li(p,p\alpha)$, and $^{12}C(p,p\alpha)$ reactions; (γ,pt) reactions; the large reduced widths of processes involving expulsion of heavy particles; and the number of effective degrees of freedom of a nucleus as revealed by its level spacing. Cluster model wavefunctions in a Gaussian Serber potential are derived. Several topics are discussed in somewhat more detail, including the structure of ^8Be; the $^9Be(\gamma,n)$, and $^9Be(\gamma,p)$ reactions; the low-lying levels in the mirror nuclei ^{19}F and ^{19}Ne; the magnetic moments of light nuclei;

the expulsion of ^{3}He and ^{3}H from ^{56}Fe by 100- to 600-Mev protons. (ATD)

16887 MANY-NUCLEON CLUSTERS IN THE PERIPHERAL NUCLEAR REGION EVINCED IN REACTIONS WITH FAST PARTICLES. V. V. Avdeichikov, V. I. Bogatin, O. V. Lozhkin, N. A. Perfilov, and Yu. P. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1573-7(Oct. 1964). (In Russian)

The energy and angular distributions of ^{8}Li nuclei ejected from ^{12}C, ^{27}Al, and ^{51}V by 660-Mev protons were investigated. The energy distribution was found to depend on the angle of expulsion. At low angles all the spectra have high-energy tails corresponding to momenta of the order of the total momentum of the incident proton. The energy distributions of ^{8}Li from ^{12}C at 20 and 90° are very similar to the corresponding distributions of residual ^{8}Li nuclei from the disintegration of ^{9}Be by high-energy protons, and it is concluded that the ejected ^{8}Li nucleus is formed by direct reaction of the incident proton with a ^{9}Be cluster within the ^{12}C nucleus. The spectrum of ^{8}Li from ^{27}Al was calculated on the assumption that it is formed from a ^{9}Be cluster and is subject to absorption by the residual nucleus. Good agreement with experiment was found. The spectrum of ^{8}Li from ^{51}V was calculated on the assumption that ^{8}Li is formed only during the evaporation stage of the reaction. Fair agreement with experiment was obtained for large expulsion angles, but the observed yield at low angles was considerably greater than the calculated. It is concluded that direct reactions with clusters in the peripheral region make a significant contribution in this case also. (ATD)

16888 COLLECTIVE EXCITATION AND DEFORMABILITY OF NUCLEI. A. S. Davydov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1578-98(Oct. 1964). (In Russian)

A review is presented of recent theoretical work on collective excitations of nuclei. Only those theories are discussed in which different nuclei are described independently. Even-even nuclei are stressed, in which single-particle and collective excitations can be clearly distinguished because of the large excitation energy of the former. The Hamiltonian for the even collective excitation of an even-even nucleus is written, and various approximations are discussed briefly. Axially symmetric nuclei are discussed in some detail on the basis of a model in which the reciprocal rigidities of the nucleus with respect to axial and transverse vibrations appear as independent parameters. These parameters are found to be larger for near magic nuclei than for other nuclei; this corresponds to the weakened coupling between the outer nucleons and the doubly magic core in these nuclei. Spherical nuclei and nuclei without a symmetry axis are discussed briefly. Investigation of the first two excited states is not sufficient to determine whether or not a nucleus is spherical. Electric monopole transitions are briefly considered, which involve a radial redistribution of charge. The theoretical probabilities for E0 transitions between spin 0 and spin 2 states are compared with experimental values for a number of nuclei. Such comparisons frequently make it possible to arrive at unambiguous spin assignments for excited states. The theory of almost doubly magic nuclei is still unsatisfactory. The spectra of these nuclei cannot be accounted for by quadrupole surface vibrations about a spherical shape. Further investigation is required, and it is suggested that a study of E0 and E2 transition probabilities may prove helpful. The model of an odd nucleus in which the odd nucleon is regarded as moving in the field of an ellipsoidal even-even core that executes surface vibrations is considered finally. Mention is made of some interesting predictions, based on this model, that have not yet been tested experimentally. (ATD)

16889 INVESTIGATION OF OCTUPOLE STATES OF STRONGLY DEFORMED EVEN-EVEN NUCLEI. V. G. Solovev, P. Fogel', and A. A. Korneichuk. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1599-1616(Oct. 1964). (In Russian)

A systematic theoretical investigation is presented of the energies and structures of the octupole excited states with $\lambda = 3$ and $\mu = 0, 1, 2, 3$ in strongly deformed even-even nuclei. The calculations are performed on the basis of the superfluid model by the method of approximate second quantization. The derived secular equation is simplified on the assumption that the three octupole-octupole interaction constants (for the pp, nn, and pn interactions) are equal. Calculations were performed for the even-even nuclei with mass numbers between 150 and 190, and between 228 and 254. Nilsson wave functions were employed, with the deformation parameter δ assumed to have the same value 0.3 for all the nuclei in the lighter group, and the value 0.2 for those in the heavier group. The octupole-octupole interaction was also assumed to be constant within each of these two groups; the interaction constant was so chosen as to give the best agreement with the experimental energies of the 0^- states. The first two roots of the secular equation were calculated for the 0^-, 1^-, 2^-, and 3^- states, and the energy values, together with the energies of the first and second bands and the corresponding experimental data (when available) are presented graphically. The calculated values of the energies of the lowest 1^-, 2^-, and 3^- states agree well with the experimental values, provided the effect of blocking is taken into account when it is important. The octupole-octupole interactions are usually important for 1^- and 2^- states, and are usually negligible for 3^- states. The structures of the octupole states are illustrated by tabulating the contributions of the various two-quasiparticle states for a number of selected nuclei. In most nuclei the lowest 0^- state is strongly collectivized, whereas the 1^- and 2^- states may be collectivized, but are usually rather close to two-quasiparticle states. The 3^- states may be regarded as two-quasiparticle states with less than 1% admixture of other than the principal state. Reduced electromagnetic transition probabilities were calculated. (ATD)

16890 ENERGIES OF THE EXCITED STATES OF SOME STRONGLY DEFORMED EVEN-EVEN NUCLEI WITH MASS NUMBERS BETWEEN 164 AND 190. N. I. Pyatov and V. G. Solovev (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1617-30(Oct. 1964). (In Russian)

The energies of a number (averaging 19 per nucleus) of non-rotational states of each of the following even-even nuclei were calculated on the basis of the superfluid model with blocking taken into account and the results are tabulated: ^{164}Dy, ^{164}Er, ^{168}Yb, ^{174}Yb, ^{176}Yb, ^{178}Hf, ^{184}W, and ^{186}Os. The structures of states containing more than 5% admixture are shown in tables. Beta transitions to levels of four of the above nuclei were analyzed, and the results of the analysis are included in the respective tables. The same system of average field levels was used for all the calculations — it was assumed that the nuclei are all equally deformed. The level system employed is very similar to that given by Nilsson and Prior, but was slightly altered to take account of more recent data concerning the single-particle levels of odd nuclei. The parameters employed in the calculations are tabulated. Many features of the results are discussed in detail, and a number of previously proposed assignments are questioned. Since superfluid model calculations of two-quasiparticle excitation energies are performed separately for the neutron and proton systems, it is possible to obtain the energies of two-quasiparticle excited states of all nuclei with $90 \leq N \leq 110$ and $62 \leq Z \leq 76$ from the results, together with previously published data. (ATD)

16891 DECAY OF THE 169-DAY METASTABLE STATE OF ^{184}Re. B. S. Dzhelepov, P. A. Tishkin, and I. A. Shishelov. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1631-6 (Oct. 1964). (In Russian)

The conversion electron spectrum of a cyclotron-irradiated tungsten target was examined during a period of 18 months in order to obtain information concerning the decay of the 169-day metastable state of ^{184}Re. A double toroidal β spectrometer with a resolution of 1.5% was used, and coincidences were counted with a fast-slow circuit

having a resolving time of 10 nsec. Nine conversion peaks were observed in the energy range from 25 to 125 kev, of which four fell off in intensity with a period close to 169 days. Many of the observed peaks were revealed by their decay and their coincidence behavior to be complex. A number of transitions in ^{184}Re, ^{184}W, and ^{183}W were identified (some tentatively), and information concerning their multipolarities was obtained from the intensity ratios. It was established that the decay of the metastable state of ^{184}Re is complex, but the data are too scanty for construction of a decay scheme. Transitions of 55- and 163-kev energy in ^{184}Re were observed in coincidence. The sum of these energies corresponds closely to the energy of the 217 kev γ rays observed by Johnson, who also detected 163 kev γ rays. These transitions were of low multipolarity and accordingly connect states with close spin values. (ATD)

16892 DETERMINATION OF THE NUCLEAR MODEL OF LEVELS BY MEANS OF DIRECT (d,p) AND (d,d′) REACTIONS. N. I. Zaika, O. F. Nemets, and V. V. Tokarevskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1637-56(Oct. 1964). (In Russian)

A review is presented of studies of (d,p) and (d,d′) reactions from the point of view of determining the model nature (energy, spin, parity, transition probability, etc.) of the nuclear levels involved. Many experimental data are reviewed, and the inferences that can be drawn from them are discussed in detail. The raw experimental data from (d,p) and (d,d′) reactions are the gross structure of the energy spectra of the reaction products and angular distributions. In the (d,p) reaction, principally single-particle neutron states are excited. Much information concerning them can be obtained, including reduced widths and spectroscopic factors, neutron shell structure and the vibrational nature of some levels. The states participating in inelastic scattering are mostly collective, and the spectrum of the scattered deuterons changes smoothly from one target nucleus to a neighboring one. The spectrum regularly shows a strong peak at an energy transfer of about 1 Mev and (for heavy nuclei) a broad "anomalous" peak at about 2.5 Mev. The first peak corresponds to the excitation of a single-phonon quadrupole 2^+ level, and the anomalous peak to a 3^- octupole level. Simple stripping theory (plane wave Born approximation) is adequate for analyzing angular distributions at small angles when the incident deuteron energy exceeds 10 Mev, and the mass number of the target nucleus is less than 100. For heavy target nuclei, low-energy deuterons, or large scattering angles, this approximation is no longer adequate. Considerable success was achieved with a distorted-wave Born approximation in which the distortions due to both the Coulomb and the optical potentials are included. The (d,t), (d,^{3}He), (d,α), (α,p), (α,n), (α,d), (α,t), and (α,^{3}He) reactions are discussed very briefly. Many more experimental data concerning α-particle reactions are needed before clear conclusions can be drawn. (ATD)

16893 PROPERTIES OF THE LEVELS AND RADIATIONS OF THE ODD-A NUCLEI Cs^{131} AND Cs^{133}. G. A. Vartapetyan, T. A. Garibyan, N. A. Demekhina, E. G. Muradyan, and A. G. Khudaverdyan (State Committee on the Uses of Atomic Energy, SSSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1657-63(Oct. 1964). (In Russian)

Delayed γ-coincidence measurements were performed with ^{131}Cs (and in one case with ^{133}Cs) in order to obtain information concerning the nature of the excited states and the extent to which they involve collective motions. KI crystals were used in a delayed coincidence circuit with a resolving time of 10^{-8} sec. The performance of the circuit was checked by observing prompt coincidences from ^{60}Co. Using the known different lifetimes of the 124- and 133-kev ^{131}Cs levels, it was determined from the delayed coincidence measurement results that the 1039-kev level decays almost 15 times more frequently to the 124-kev level than to the 133-kev level. This contradicts conclusions drawn from the model of Person and Rasmussen. The half life of the 620-kev ^{131}Cs state was measured by triple coincidences, and that of the 438-kev ^{133}Cs state was measured by a similar method. Both half lives were found to be less than 1.5×10^{-10} sec. The half life of the 1039-kev ^{131}Cs state was found to be less than 2×10^{-9} sec. The half life of the 133-kev ^{131}Cs state was found to be 13.5×10^{-9} sec; this is in agreement with the finding of Bodenstedt. The angular correlation of the 495- and 124-kev γ rays of ^{131}Cs was examined, and an anisotropy of the order of 0.01 was found. It is concluded that the decay of the 124-kev level is 97% by M1 transition and 3% by E2. The ratio of the reduced E2 width to the theoretical value for a single-particle state was found to be greater than 4.5 for the 356-kev ^{133}Cs state, greater than unity for the 495-kev ^{131}Cs state, and approximately 6 for the 133-kev ^{131}Cs state. These estimates are in satisfactory agreement with calculations of Sorensen, in which nucleon pairing and collective vibrations were taken into account. The significance of these findings for models of odd-A nuclei is discussed. (ATD)

16894 MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF ELECTRONS IN THE BETA DECAY OF S^{35}. R. O. Avakyan, L. G. Arutyunyan, and M. V. Nersesyan. Izv. Akad. Nauk SSR, Ser. Fiz., 28: 1664-6(Oct. 1964). (In Russian)

The longitudinal polarization of the electrons emitted in beta decay of ^{35}S was measured at energies of 40, 70 and 100 kev. The measurements were undertaken to test a suggested correlation between the deviations of the longitudinal polarization of allowed beta particles from the usual value v/c (v is the velocity of the electron) and deviations of the beta spectrum from the Fermi shape. ^{35}S was chosen for investigation because its beta spectrum is well known to follow the Fermi law to the very lowest energies. The polarization was measured by Mott scattering after the longitudinal polarization had been transformed to transverse by electrostatic deflection. The resolution of the electrostatic beta spectrometer was 7%. The ^{35}S source consisted of aluminum sulfate on a 4-micron aluminum support. Gold was used as the scatterer. A 30-kv retarding potential was applied between the source and the spectrometer during the 100-kev measurements, but no accelerating potential was applied during the 40-kev measurements. The scattering was measured at angles from 107 to 137° and was extrapolated to zero scatterer thickness with corrections for instrumental asymmetry and scattering from the deflector plates. Corrections were applied for the finite solid angle, screening, and depolarization in the source. The ratio of the longitudinal polarization to v/c was found to be 1.04 ± 0.10, 0.96 ± 0.04 and 0.93 ± 0.04 at 40, 70 and 100 kev, respectively. (ATD)

16895 COULOMB EXCITATION OF Co^{59}, Ni^{61}, Zn^{67}, Mo^{95}, Mo^{97}, Rh^{103}, Pd^{105}, Cd^{111}, In^{115}, Cs^{133} AND Dy^{163}. D. G. Alkhazov, K. I. Erokhina, and I. Kh. Lemberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1667-82(Oct. 1964). (In Russian)

A continuation is reported of the systematic investigation of the excited states of odd-A nuclei. The eleven odd nuclei mentioned in the title were excited by bombardment with quadruply or pentuply charged nitrogen ions at energies from 35 to 52 Mev, and the excited states were observed by counting coincidences of gamma rays with the scattered ions. The observed coincidence spectrum of each of the nuclei is discussed in detail with numerous references to the literature. Reduced E2 excitation probabilities and partial life-times for E2 transition to the ground state were obtained for 33 levels of the 11 nuclei. These quantities have not previously been reported for 25 of the levels, and 7 of the levels had not previously been observed. A number of spin and parity assignments were made (some tentative), and information concerning the relative intensities of some gamma transitions was obtained. Using the data of Booth and Wright, it was determined that the intensity ratio of the E2 to M1 gamma transitions from the 1.19-Mev ^{59}Co level is approximately 4%. Some of the results are compared with predictions of the excited core model of Lawson and Uretzky and de Shalit. The nuclei with spin $\frac{1}{2}$ showed the expected doublets with approximately equal B(E2) values, but the centers of gravity of the doublets were approxi-

mately 0.15 Mev below the corresponding 2^+ level of the core nucleus. The center of gravity law was better satisfied by ^{59}Co and ^{115}In multiplets, but the B(E2) values varied considerably. (ATD)

16896 ANGULAR DISTRIBUTION OF GAMMA-RADIATION EMITTED IN COULOMB EXCITATION OF ODD-A NUCLEI. D. G. Alkhazov, V. D. Vasil'ev, G. M. Gusisnkii, I. Kh. Lemberg, and V. A. Nabichvrishvili. Izv. Akad. Nauk SSR, Ser. Fiz., 28: 1683-94(Oct. 1964). (In Russian)

The angular distribution of the gamma rays resulting from from Coulomb excitation of the following odd nuclei was investigated: ^{21}Ne, ^{45}Sc, ^{47}Ti, ^{57}Fe, ^{67}Zn, ^{69}Ga, ^{77}Se, ^{85}Rb, ^{87}Rb, ^{105}Pd, ^{123}Sb, ^{123}Te, ^{127}I, ^{133}Cs and ^{147}Sm. All the nuclei except ^{21}Ne were excited by bombardment with 16.1-Mev nitrogen ions. The ^{21}Ne gamma rays were obtained by bombarding an aluminum target with 24 Mev ^{21}Ne ions. The gamma radiation was recorded at 0, 30, 60 and 90° with four NaI scintillators, the relative efficiencies of which were determined by counting the gamma rays from standard radioactive sources located at the target position. The coefficients of second and fourth degree Legendre polynomials in the expansion of the angular dependence of the intensity were obtained by the method of least squares, but the coefficients of the fourth degree polynomials were so small that they are disregarded in subsequent analyses. The portion of the anisotropy due to the Coulomb excitation process was calculated by a standard method, and the remaining anisotropy, after correction for instrumental effects, is ascribed to gamma-gamma correlations in cascade processes. From this the residual anisotropy, the spin and parity of the residual state and the E2 and M1 transition branching ratio were determined (in some cases tentatively), and the results are tabulated. Reduced M1 transition probabilities were obtained for 11 of the nuclei, and these and the corresponding theoretical single-particle values are tabulated. The data concerning each of the nuclei are discussed in detail with numerous references to the literature. (ATD)

16897 INVESTIGATION OF CASCADE TRANSITIONS IN THE RADIATIVE CAPTURE OF NEUTRONS BY Sc^{45}. A. M. Berestovoi, I. A. Kondurov, and Yu. E. Loginov. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1695-1700(Oct. 1964). (In Russian)

Delayed coincidences were observed between the soft gamma rays accompanying the ^{45}Sc(n,γ)^{46}Sc reaction, and a level scheme was derived for the low-lying levels of ^{46}Sc. This nucleus was chosen for study because it is light and spherical, and should therefore have a simple level scheme. The specimen was exposed to the 1 cm diameter collimated thermal neutron beam from the heavy water reactor at the Physicotechnical Institute of the AN SSSR. The detectors of the scintillation spectrometer were located 5 cm from the specimen at right angles to the neutron beam. Delays from 10^{-9} to 10^{-7} sec were determined with a time-to-amplitude converter and a pulse height analyzer. Delays from 10^{-3} to 10^{-1} sec were determined by chopping the neutron beam. Longer delays were investigated with a pendulum conveyer that brought the specimen from the beam to the spectrometer. The gamma energies determined with the scintillation spectrometer were in satisfactory agreement with those measured with a crystal spectrometer by Fiebiger, Rasmussen, Neill and Rahman, and the latter energies were employed in constructing the level diagram. The results of (d,p) measurements were also employed in constructing the diagram. Each gamma transition and level is discussed in some detail, and the resulting level scheme is shown. (ATD)

16898 RETARDED TRANSITIONS IN Eu^{152} AND Eu^{154}. A. M. Berestovoi, I. A. Kondurov, and Yu. E. Loginov. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1701-3(Oct. 1964). (In Russian)

Delayed coincidences were observed between the soft and hard gamma rays produced by thermal neutron capture in ^{151}Eu and ^{153}Eu. These nuclei were selected for study because they lie near the boundary between spherical and deformed nuclei. The gamma rays were detected by 4 × 4 cm^2 NaI crystals, and the delays were determined with a time-to-amplitude converter. One soft gamma ray (90 kev) was observed from ^{152}Eu and two (68 and 97 kev) from ^{154}Eu. These followed the hard gamma rays with delays that indicated lifetimes of 4×10^{-7}, 4×10^{-8} and 7×10^{-9} sec, respectively. The internal conversion coefficients for these gamma transitions were determined by examining delayed γ-X coincidences. From the measured delays and internal conversion coefficients, it is concluded that the 68-kev gamma ray is due to an E1 transition, the 90 kev to an E1 transition with a slight admixture of M2, and the 97 kev to an E2 transition. The 90-kev ^{152}Eu gamma ray had previously been ascribed to an E2 transition. (ATD)

16899 NEW DATA ON THE CONVERSION ELECTRON SPECTRUM OF Ta^{182} IN THE ENERGY REGION ABOVE 820 kev. V. A. Balalaev, N. A. Voinova, B. S. Dzhelepov, A. Meshter, and S. A. Shestopalova. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1704-10(Oct. 1964). (In Russian)

The conversion electron spectrum of 115-day ^{182}Ta was investigated with a double $\pi\sqrt{2}$ focusing beta spectrometer. The measurements were undertaken in order to record the spectrum at energies above 1220 kev, where it has not previously been adequately investigated. The source was a tantalum film vacuum evaporated onto an aluminum backing. It was activated with thermal neutrons and was examined four months later. Thirty-eight conversion lines with energies from 822 to 1387 kev were detected and identified, 20 of which had not previously been reported. The observed lines and their relative intensities are tabulated, and the data are also presented graphically with the statistical errors shown. The relative intensities are compared with those obtained by Gvozdev, Vasilenko, Kondratyev, and Starodubtsev. The present data, except for three lines, are in very good agreement with those of Kondratyev, and they are in satisfactory agreement with those of Gvozdev and of Vasilenko. There are large unsystematic deviations from the relative intensities reported by Starodubtsev. (ATD)

16900 INVESTIGATION OF THE LOW-LYING STATES OF Si^{30}. O. F. Nemets, Yu. S. Stryuk, and V. V. Tokarevskii (Physics Inst., Academy of Sciences, Ukrainian SSR) Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1711-13(Oct. 1964). (In Russian)

The energy and angular distribution of protons from the ^{27}Al(α,p)^{30}Si reaction with 27.2-Mev alpha particles was investigated in order to assess the utility of alpha particle reactions for nuclear spectroscopic investigations. This reaction was selected for study because the excited states of both nuclei are well known. Three groups of protons were distinguished, corresponding to the 0^+ ground state, the 2^+ 2.25-Mev state, and the 3.61- and 3.89-Mev states of ^{30}Si. The angular distributions are compared with predictions of theories of proton pick-up, triton stripping, and successive stripping. Good agreement was obtained with the predictions of the successive stripping theory for angles less than 55° in the center of mass system, but with a cut-off parameter that exceeds the nuclear radius of 2 fermi. It is concluded that the (α,p) reaction can serve as a nuclear spectroscopic tool, but that many more experimental data are required and a distorted wave theory of the reaction must be developed. (ATD)

16901 INVESTIGATION OF THE LOW-LYING STATES OF Mg^{25}. V. N. Dobrikov, F. Pikar, O. F. Nemets, Yu. S. Stryuk, and V. V. Tokarevskii (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1714-16(Oct. 1964). (In Russian)

The energy and angular distribution of alpha particles from the ^{27}Al(d,α)^{25}Mg reaction with 13.6-Mev deuterons was investigated in order to assess the utility of (d,α) reactions for nuclear spectroscopy investigations. A semiconductor detector with a resolution of 70 kev was employed with a 50-channel pulse height analyzer. Eight groups of alpha particles were distinguished, corresponding to 13 levels of ^{25}Mg. All the angular distributions showed a rise at small angles, but in contrast to the case of other nuclear reactions, the diffraction structure was not marked. The angular distributions were compared with the two-nucleon pick-up theory of El-Nadi, and encouraging agreement was found. It was found that, in contrast with the behavior ob-

served in (d,p) reactions, the probabilities for the transfer of all angular momenta permitted by the selection rules were approximately equal. (ATD)

16902 INVESTIGATION OF THE (d,α) REACTION ON Al^{27} AT DEUTERON ENERGIES FROM 1.5 TO 2.6 Mev. DEPENDENCE OF THE α-GROUP ABUNDANCES ON THE SPIN OF THE FINAL STATE OF Mg^{25}. M. A. Abuzeid, Yu. P. Antuf'ev, A. T. Baranik, M. I. El'-Zaiki, T. M. Nover, and P. V. Sorokin. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1717-20(Oct. 1964). (In Russian)

The energy and angular distributions of alpha particles from the $^{27}Al(d,\alpha)^{25}Mg$ reaction were measured at 12 different deuteron energies from 1.506 to 2.54 Mev. Eight alpha particle groups were distinguished, corresponding to ten ^{25}Mg levels. The angular distributions of the various groups were measured at angles greater than 70°. The angular distributions varied greatly with deuteron energy but were generally symmetric about 90°. This indicates that the reaction proceeds by compound nucleus formation with participation of a moderate number of levels. The yields of the different alpha particle groups were found by integrating the angular distributions. The results of integration were corrected for barrier penetration by the ejected alpha particle, divided by 2I + 1, where I is the spin of the corresponding ^{25}Mg state; the final values are tabulated. The quotients (normalized to unity for the highest energy group) varied from 0.54 to 1.68. When the quotients for each group were averaged over all the incident deuteron energies, however, the variation was only from 0.89 to 1.22. It is concluded that the intensities of the α particle groups from (d,α) reactions, when adequately averaged over the incident deuteron energy, are proportional to 2I + 1, as indicated by the statistical compound nucleus theory, and can be employed to determine nuclear spins. The present results were compared with those obtained by MacDonald with 10-Mev deuterons. The mean square deviation from proportionality to 2I + 1 was 10% for the present data and 18% for those of MacDonald. (ATD)

16903 HELIUM ION-INDUCED FISSION OF ^{197}Au FROM 41.1 Mev TO 26.8 Mev. E. F. Neuzil (Western Washington State Coll., Bellingham, Wash.). J. Inorg. Nucl. Chem., 27: 3-12(Jan. 1965).

A study was made of the helium-ion-induced fission of ^{197}Au at excitation energies of 40.2, 33.3, 27.9, and 25.9 Mev. The fission fragment mass distribution curves at these levels of excitation were symmetrical gaussian distributions whose width at half maximum, $W_{½}$, appeared to have an energy independent value of 15 ± 1 mass units. Charge distribution effects were shown to be negligible and the cross sections for fission determined from the mass distribution curves did not need to be corrected for charge distribution effects. It was also observed that second chance fission is not a favorable process, and the chance of neutron evaporation from the compound nucleus drops rapidly with the energy of the fissioning species at the saddle point. The cross sections for fission at the four excitation energies of 40.2, 33.3, 27.9, and 25.9 Mev are 0.43, 0.030, 0.0052, and 0.0014 mbarns respectively. (auth)

16904 RATIO OF ^{115}Cd ISOMERS PRODUCED IN HEAVY-ION-INDUCED FISSION. T. Sikkeland and G. R. Choppin (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 27: 13-19(Jan. 1965). (UCRL-10226)

Isomeric cross-section ratios were measured for the formation of ^{115}Cd isomers in ^{12}C and ^{16}O-induced fission in ^{197}Au and ^{238}U. The cross-section ratio (high spin/low spin) varied from 1.60 to 3.43 for the system $^{197}Au + ^{12}C$ with energies ranging from 73 to 120 Mev. In the same energy range the ratio for the system $^{238}U + ^{12}C$ varied from 0.55 to 0.82. The average intrinsic spin, $\langle l_f \rangle$, of the fragment that decays to the ^{115}Cd isomer pair was estimated from a simple model. The cross-section ratio showed the same relative increase with $\langle l_f \rangle$, for both targets. At the same value for $\langle l_f \rangle$ the ratio was much larger for ^{197}Au than for ^{238}U. It is suggested that this difference is related to the fact that in the Au system, the ^{115}Cd is produced in a more asymmetric division. (auth)

16905 HALF-LIVES OF ^{90}Sr AND ^{137}Cs. K. F. Flynn, L. E. Glendenin, A. L. Harkness, and E. P. Steinberg (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 27: 21-3(Jan. 1965).

The half lives of ^{90}Sr and ^{137}Cs were measured both by specific activity and by direct decay over periods of 6 to 10 years. Results from the decay measurements are 28.0 ± 0.4 years for ^{90}Sr and 29.9 ± 0.5 years for ^{137}Cs; the values obtained by specific activity measurements are 28.5 ± 0.9 years for ^{90}Sr and 30.9 ± 0.7 years for ^{137}Cs. Recommended "best" values for these half lives based on current literature values are 28.1 ± 0.3 years for ^{90}Sr and 30.0 ± 0.2 years for ^{137}Cs. (auth)

16906 DETERMINATION OF THE HALF-LIFE OF THE LONGER-LIVED ^{166}Ho ISOMER. K. T. Faler (Phillips Petroleum Co., Idaho Falls, Idaho). J. Inorg. Nucl. Chem., 27: 25-7(Jan. 1965).

A measurement of the half life of >30 year ^{166}Ho was carried out by a specific activity determination of a highly irradiated holmium sample. The sample was carefully purified chemically, its activity measured by γ spectrometry, and its ^{166}Ho content measured on a mass spectrometer. The half life was found to be 1.2×10^3 years with an estimated uncertainty of about 15% exclusive of uncertainties in the conversion coefficient and relative intensity of the γ transition. (auth)

16907 NUCLEAR CONSTANTS OF NINE TRANSPLUTONIUM NUCLIDES. D. Metta, H. Diamond, R. F. Barnes, J. Milsted, J. Gray, Jr., D. J. Henderson, and C. M. Stevens (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 27: 33-9(Jan. 1965).

The total half lives of ^{252}Cf, ^{250}Cf, ^{253}Cf are 2.646 ± 0.004 years, 13.2 ± 0.5 years, and 17.6 ± 0.2 days. The ratios of α emission to spontaneous fission for ^{252}Cf, ^{250}Cf, ^{253}Es, and ^{244}Cm are 31.3 ± 0.2, 1260 ± 40, (1.15 ± 0.03) × 10^7, and (7.43 ± 0.01) × 10^6. The partial spontaneous fission half life of ^{246}Cm = (1.66 ± 0.10) × 10^7 years. The thermal neutron fission cross sections for ^{249}Cf and ^{251}Cf are 1735 ± 70 and 3000 ± 260 barns. A separate determination and a re-evaluation of data from the MIKE thermonuclear event confirmed the 60.5 ± 0.2 day ^{254}Cf half life reported by others. (auth)

16908 CROSS SECTION OF THE $^{63}Cu(n,\alpha)^{60}Co$ REACTION. D. M. Clare and W. H. Martin (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Nucl. Energy, Pt. A&B, 18: 703-4(Dec. 1964).

A Cu sample was irradiated in the Dounreay MTR for 24 days. Fast-neutron flux was determined using iron foils and thermal-neutron flux from the $^{59}Cu(n,\gamma)^{60}Co$ reaction. The ^{60}Co activity from the $^{63}Cu(n,\alpha)^{60}Co$ reaction was measured using sum peak scintillation counting. From these data, the $^{63}Cu(n,\alpha)^{60}Co$ cross section was calculated to be (0.45 ± 0.05) mb. (M.J.T.)

16909 A REMEASUREMENT OF THE HALF-LIFE OF ^{235}U. P. H. White, G. J. Wall, and F. R. Pontet (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy: Pt. A and B, 19: 33-5(Jan. 1965).

The alpha spectra of uranium samples with different isotopic compositions were measured together with the alpha energies and branching ratios for ^{235}U and the branching ratios for alpha particles from ^{234}U and ^{236}U. The half lives of ^{234}U and ^{235}U were determined to be $2.47 \pm 0.03 \times 10^5$ and $7.13 \pm 0.09 \times 10^8$ yr, respectively. (D.C.W.)

16910 NEGATIVE ENERGY LEVEL AND TEMPERATURE COEFFICIENT OF THERMAL NEUTRON ABSORPTION RATE OF Th-232. Massashi Iizumi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 39-40(Jan. 1965).

The thermal neutron absorption cross section of ^{232}Th deviates slightly from the 1/v dependence. Contributions to the cross section from the levels of the compound nucleus ^{233}Th below the binding energy of the neutron, the "negative" energy levels, were indicated. The resonance

parameters of the negative levels were estimated by curve-fitting the total cross section data using the least squares method. The temperature coefficient of the Maxwellian averaged absorption cross section was determined. The deviation of the thermal neutron absorption cross section was dependent on these two factors. (M.C.G.)

16911 COULOMB EXCITATION OF LEVELS IN Cu^{63} AND Cu^{65}. B. Elbek, H. E. Gove, and B. Herskind (Univ. of Copenhagen). Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd., 34: No. 8, 1-45(1964).

Levels in ^{63}Cu at 0.668, 0.961, and 1.327 Mev and in ^{65}Cu at 0.770, 1.114, and 1.182 Mev were studied by the technique of Coulomb excitation, using 36-Mev ^{16}O ions. Spin assignments of $\frac{1}{2}$, $\frac{3}{2}$, and $\frac{7}{2}$, respectively, for the two sets of levels were made, based on angular correlations of the cross-over gamma rays to the ground state measured in coincidence with ^{16}O ions scattered into a counter near 180°. Relative B(E2) for the levels in ^{63}Cu as given above were found to be 1.00, 1.01 ± 0.03, and 1.10 ± 0.03, while that for the 1.862-Mev level was less than 0.2 (assuming $J = \frac{3}{2}$). In ^{65}Cu the values were 1.00, 1.11 ± 0.04, and 0.97 ± 0.03, while that for the 1.623-Mev level was less than 0.2 (again assuming $J = \frac{3}{2}$). The absolute values of B(E2) for decay of the 0.845-Mev level in ^{56}Fe, the 0.668-Mev level in ^{63}Cu, and the 0.770-Mev level in ^{65}Cu were measured to be 0.019, 0.021, and 0.016 (in units of $e^2 \times 10^{-48}$ cm^4), respectively. The 1.327-Mev level in ^{63}Cu branches to the 0.668-Mev level with a 9% probability and the 1.482-Mev level in ^{65}Cu branches to that at 0.770 Mev 24% of the time. E2–M1 amplitude ratios for the transition between the $\frac{5}{2}$-level and the ground state in both nuclei were measured to be −0.2. Estimates were made of various second-order Coulomb excitation effects that can change the relative B(E2). The experimental results are considered in relation to various current core excitation models. (auth)

16912 $C^{12}(C^{12},\alpha)Ne^{20}$ CROSS SECTION MEASUREMENTS. J. Borggreen, B. Elbek, and R. B. Leachman (Univ. of Copenhagen). Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd., 34: No. 9, 1-19(1964).

The reaction $^{12}C(^{12}C,\alpha)^{20}Ne$ was investigated for 9 to 16 Mev center-of-mass energies. The alpha particles were detected with semiconductor detectors in a geometry which resolved the individual alpha-particle groups feeding the five lowest states in ^{20}Ne. Excitation functions of the differential cross sections at center-of-mass angles of 0, 37.3, and 90° showed strong fluctuations in the yields with no definite cross correlation between the positions of the maxima for different alpha-particle groups. In most cases, the angular distributions of the alpha-particles to the ground state contained a dominant contribution from a squared Legendre polynomial of one definite order, usually 8 or 10. Angular distributions for each of the alpha-particle groups populating the excited states were more complex. The general structure of the yield curves and angular distributions is in agreement with the statistical theory of overlapping resonances of the compound nucleus. (auth)

16913 MODERN PROBLEMS OF NUCLEAR SPECTROSCOPY AND THE HUNGARIAN RESULTS. Denes Berenyi (Nuclear Research Inst., Hungarian Academy of Sciences, Debrecen). Magy. Fiz. Folyoirat, 10: 515-26 (1962). (In Hungarian)

After a general review of the methods used for the determination of the nuclear levels, the current work in the Hungarian research institutes in the field of the nuclear spectroscopy of radioactive radiations is summarized. It is emphasized that there is no generally valid theory which is able to explain the large body of low-level data on the about 1600 nuclides, including spin, parity, life time, electric dipole and magnetic quadrupole moments. The alpha-spectrum of ^{210}Po was studied by an alpha-gamma coincidence technique, it was found that the energy of the low-intensity group of that spectrum is 4.525 ± 0.005 Mev. Odd nuclei were studied by beta and gamma spectroscopy, coincidence techniques, and gamma-gamma angular correlations. The existence of the previously doubtful 529 ± 25 kev maximum-energy group was confirmed for ^{147}Nd; 143 → 1289, 335 → 1097, and 192 → 1097 kev cascades were found for the case of ^{59}Fe. The gamma radiation of ^{131}I was also examined, a new decay scheme was proposed on the basis of the data. The work in progress includes the study of the decay of ^{227}Ac by alpha spectroscopy and the investigation of the low-intensity positron emission in the decay of several nuclei, the alpha-decay of deformed nuclei, and the dynamic structural effects in the case of internal conversion. 96 references. (TTT)

16914 THE INFLUENCE OF THE INTERFERENCE OF DIRECT AND COMPOUND PROCESSES ON THE (p,γ) REACTIONS. Ilona Fodor (Central Physical Research Inst., Budapest). Magy. Fiz. Folyoirat, 12: 427-37(1964). (In Hungarian)

It has been shown that direct neutron capture is possible, if the scattered slow neutrons are captured from the scattered s state, passing into the bound p state without forming a compound nucleus while emitting an electric dipole radiation. However, if the (n,γ) and (p,γ) reactions take place directly, under the formation of a compound nucleus, the two processes may cause an experimentally observable interference. In such a case, the cross section of the (n,γ) reaction and the angular distribution of the resulting gamma radiation are strongly energy dependent near the resonance region. This theory was applied to the case of $^{11}B(p,\gamma)^{12}C$ and $^{7}Li(p,\gamma)^{8}Be$ reactions, calculating the angular distribution functions related to the formation of an intermediate nucleus. By using simplifying assumptions, by neglecting the energy dependence of the parameters, it was found possible to define the processes. It was concluded that under conditions leading to the formation of compound nuclei, a direct (p,γ) capture occurs with the above (p,γ) reaction; the effect of the interference can be demonstrated in the energy dependence of the angular distribution of the generated x radiation. (TTT)

16915 ^{232}Th AND ^{238}U FISSION INDUCED BY LOW-ENERGY MONOCHROMATIC GAMMA-RAYS. II. ANGULAR DISTRIBUTIONS AT 6.61 Mev. A. Manfredini (Istituto Nazionale di Fisica Nucleare, Rome and Universita, Rome), M. Muchnik, M. Severi, R. Boesch, W. Woelfli, and H. G. de Carvalho. Notas Fis., Centro Brasil. Pesquisas Fis., 11: No. 3, 83-103(1963).

The angular distribution of the photofission fragments of uranium and thorium was measured at 6.61 Mev, by combining a monochromatic γ-ray source with nuclear emulsion techniques. Values are given (in millibarns) for the isotopic, dipole, and quadrupole absorption cross sections in the photofission process, using previous results. (auth)

16916 THE $Be^{9}(p,\alpha)Li^{6}$ AND $Be^{9}(p,d)Be^{8}$ REACTIONS FROM 1 TO 4.6 Mev. Susumu Morita, Tsutomu Tohei, Takemi Nakagawa, Takeo Hasegawa, Hiroaki Ueno, and Chu-chung Hsu (Tohoku Univ., Sendai). Nucl. Phys., 66: 17-24(May 1965).

Excitation curves for the products of the ^{9}Be + p reaction and several angular distributions for the $^{9}Be(p,\alpha_0)^{6}Li$ and $^{9}Be(p,d_0)^{8}Be$ reactions were measured at energies from 1.00 to 4.60 Mev. Showing the typical behaviors for direct reaction mechanism, the results were compared with the pick-up theory in plane-wave Born approximation. (auth)

16917 MONOPOLE PART OF THE MAJORANA FORCE IN LIGHT NUCLEI. V. G. Neudatchin (Universitet, Copenhagen) and Yu. F. Smirnov. Nucl. Phys., 66: 25-34(May 1965).

The monopole part of the Majorana force is very important in light nuclei (A < 40). The "four-grouping" effects are created predominantly by this force, and all other parts of the residual interaction are of minor importance here. The monopole forces have no influence on the moments of inertia. Their large amplitude leads to the orbital Young-scheme [λ] description of the structure of some light nuclei and, consequently, to some specific Young-scheme selection rules in nuclear reactions. Many cluster aspects of the structure of the light nuclei are contained in

the Young-scheme description. The monopole forces also give a large diagonal shift of the energy of the giant dipole resonance. (auth)

16918 GIANT RESONANCE IN HEAVY NUCLEI. A. A. Lushnikov and D. F. Zaretskii (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 66: 35-48(May 1965).

The giant resonance in the dipole photoabsorption of nuclei is investigated. The main parameters of the photoproduction cross section (the position of the maximum, its width, the sum rule taking into account exchange forces, and the maximum splitting in deformed nuclei) are calculated with the aid of equations of the theory of a Fermi liquid in finite systems. (auth)

16919 ISOBARIC SPIN SELECTION RULE IN THE $N^{14}(d,\alpha)C^{12}$ REACTION. C. P. Browne (Univ. of Notre Dame, Ind.), W. A. Schier, and I. F. Wright. Nucl. Phys., 66: 49-64(May 1965). (TID-21146)

The $^{14}N(d,\alpha)^{12}C$ reaction leading to the 15.11 Mev and 16.11 Mev (T = 1) levels of ^{12}C violates conservation of isobaric spin. The cross section of the reaction to the 15.11-Mev level was measured by observing the alpha particles with solid state detectors and with broad-range spectrographs and by observing the 15.11-Mev gamma rays from the decay of the state. A gamma yield curve was taken from 3 to 12 Mev and shows strong resonance structure. Angular distributions of alpha particles leading to the 12.71, 15.11, and 16.11 Mev levels were measured at 7.18 Mev deuteron energy and to the 12.71-Mev level at 5.93 Mev. At 7.18 Mev the total cross sections to the 15.11- and 16.11-Mev levels are respectively 3.1% and approximately 4% of the cross section for the reaction leading to the 12.71-Mev (T = 0) state. Contrary to other (d,α) reactions in which the selection rule was observed to hold, neither initial nor final states have $J^\pi = 0^+$ in this case. (auth)

16920 A STUDY OF THE $Be^9(He^3,n)C^{11}$ REACTION. J. H. Towle and B. E. F. Macefield (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 66: 65-79(May 1965).

Angular distributions of eight neutron groups were measured at 4.2 and 5.2 Mev, and excitation curves for these groups were also obtained between 3.5 and 5.8 Mev, using a time-of-flight spectrometer. The results indicate strongly that the reaction is predominantly a direct one. Calculations were made using DWBA double stripping theory, and good agreement is obtained for the forward part of the angular distributions for several groups. The knock-on model predicts very similar angular distributions to double stripping, and these models may be equally applicable. The presence of L = 0 components in transitions where double stripping with L = 0 is forbidden, and a comparison of the present results with $^9Be(^3He,p)$ data suggest that both these processes contribute in $^9Be(^3He,n)$. Strong L = 0 components were observed for the groups leading to the ground state, 4.81- and 8.10-Mev levels of ^{11}C, indicating $J^\pi \leq 5/2^-$ for these levels. (auth)

16921 THE QUASI-SPIN FORMALISM AND THE DEPENDENCE OF NUCLEAR MATRIX ELEMENTS ON PARTICLE NUMBER. R. D. Lawson and M. H. Macfarlane (Argonne National Lab., Ill.). Nucl. Phys., 66: 80-96 (May 1965).

It is shown that the quasi-spin formalism gives, in terms of simple vector-coupling coefficients, the explicit particle-number dependence of all matrix elements that enter a shell-model calculation for the configuration j^n of identical nucleons. Reduction formulas are thus obtained which express matrix elements involving states of j^n with seniority v in terms of the corresponding matrix elements in the configuration j^v. Simple interpretations of various seniority selection rules for the matrix elements of energy and transition operators are given. The reduction formulas are generalized to mixed configurations of identical nucleons. These formal results are of considerable practical importance because seniority is a fairly good quantum number for systems of identical nucleons. (auth)

16922 COULOMB EXCITATION OF VIBRATIONAL TRIPLET STATES AND OCTUPOLE STATES IN THE EVEN CADMIUM NUCLEI. F. K. McGowan, R. L. Robinson, P. H. Stelson, and J. L. C. Ford, Jr. (Oak Ridge National Lab., Tenn.). Nucl. Phys., 66: 97-118(May 1965). (ORNL-P-647)

Oxygen-16 ions with energies of 42 to 49 Mev were used to Coulomb excite higher states in the even Cd isotopes. Double E2 excitation of the 0^+ state at 1133 kev in ^{114}Cd was observed. The E2 transition between the excited $0'^+$ state and the first 2^+ state is strongly enhanced, $B(E2, 0' \rightarrow 2)/B(E2, 2 \rightarrow 0) = 0.85 \pm 0.17$. The second 2^+ state and the 4^+ state in ^{116}Cd are degenerate to within 5 kev at 1222-kev excitation. The values obtained for the ratio $B(E2, 4 \rightarrow 2)/B(E2, 2 \rightarrow 0)$ are 1.42 ± 0.19, 1.82 ± 0.23, 1.80 ± 0.23, and 1.63 ± 0.36, respectively for ^{110}Cd, ^{112}Cd, ^{114}Cd, and ^{116}Cd. States at 2051 ± 16, 1968 ± 16, 1945 ± 16, and 1900 ± 16 kev are excited in ^{110}Cd, ^{112}Cd, ^{114}Cd, and ^{116}Cd, respectively. If these states are interpreted to be the result of direct E3 Coulomb excitation, the $B(E3, 0 \rightarrow 3)$ are 10.3, 10.6, 9.0, and 7.5×10^4 e^2fm^6 with an accuracy of ±20% provided the branching ratio of cascades to crossover from the 3^- state is large compared to unity. These B(E3) values represent enhancement of 13 to 20. They are 3 to 6 times smaller than the results derived from yield measurements with 14 to 15 Mev alpha particles at Copenhagen. (auth)

16923 ALPHA DECAY OF Gd^{150}. Iwao Ogawa (Rikkyo Univ., Tokyo), Tadayoshi Doke, Mitsuhiro Miyajima, and Atsushi Nakamoto. Nucl. Phys., 66: 119-28(May 1965).

The alpha particle energy and the half-life of ^{150}Gd were measured with a double-grid ionization chamber. Backgrounds were minimized by the grid-collector coincidence technique. The alpha particle energy was determined to be 2.715 ± 0.018 Mev by referring to that of ^{147}Sm (E_α = 2.23 ± 0.02 Mev) reported by Macfarlane. The half-life was estimated to be $(1.4 + 0.4) \times 10^6$ yr from the observed counting rate and the total number of ^{150}Gd nuclei contained in the specimen. The number was estimated from the observed beta-decay rate of the parent nuclei ^{150}Eu, which are produced by a photonuclear reaction $^{151}Eu(\gamma,n)^{150}Eu$. The experimental half-life thus obtained agrees within a factor of 4.4 with the theoretical half-life calculated from the observed alpha-particle energy on the basis of a conventional barrier-penetration theory. The results show that ^{150}Gd behaves quite normally in the systematics of rare-earth alpha-decay. (auth)

16924 STATISTICAL MODEL AND FLUCTUATION STUDIES OF THE $Al^{27}(d,\alpha)Mg^{25}$ REACTION IN THE ENERGY RANGE 5.50-8.0 Mev. I. M. Naqib, R. Gleyvod, and N. P. Heydenburg (Florida State Univ., Tallahassee). Nucl. Phys., 66: 129-43(May 1965).

Angular distributions for seven outgoing alpha groups were measured at the deuteron energies 5.6, 5.9, 6.2, 6.8, 7.4, and 8.0 Mev. Two excitation functions were measured at 80 and 160°, in 40-kev steps, in the energy range of 5.46 to 6.70 Mev. The energy spread of the incoming deuterons was less than 10 kev. By averaging the angular distribution measurements over different outgoing channels and bombarding energies, agreement with the compound nuclear statistical model is obtained. Analysis of the fluctuations in the excitation functions gives qualitative support to the assumption of predominant compound nuclear mechanism in the reaction. The coherence energy Γ is estimated to be 58 ± 8 kev for excitation energies between 23 and 24 Mev of the ^{29}Si compound nucleus. (auth)

16925 $1^- \rightarrow 0^+$ TRANSITION IN BETA DECAY OF Re^{186}. M. Sott and M. Vinduska (Inst. of Nuclear Research, Czechoslovakian Academy of Sciences, Rez and Prague). Nucl. Phys., 66: 144-8(May 1965).

Experimental data on the spectrum shape and asymmetry in beta emission from polarized ^{186}Re nuclei were analyzed, using formulas of M. Morita and R. S. Morita. The effects of nuclear charge and nuclear size were taken into account. The $M(\sigma \times r)$ matrix element was found to be

the most significant nuclear matrix element, although other contributions are not excluded. (auth)

16926 MEASUREMENT OF PROMPT $\bar{\nu}$ FOR THE NEUTRON-INDUCED FISSION OF Th^{232}, U^{233}, U^{234}, U^{238}, AND Pu^{239}. D. S. Mather, P. Fieldhouse, and A. Moat (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 66: 149-60(May 1965).

The average number of prompt neutrons emitted in the neutron-induced fission of several nuclides was measured with a large loaded-liquid scintillation counter. Determinations were made for at least four incident energies in the range thermal to 4 Mev. Relative measurements have uncertainties of between 1 and 4% and the standard for absolute values is $\bar{\nu}(^{252}Cf, \text{spontaneous}) = 3.782 \pm 0.024$. The results emphasize that the atomic number has the most influence in determining the value of $\bar{\nu}$ at a given incident energy, since the values for the uranium isotopes lie close together, but are well separated from the Pu and Th results. Parameters obtained from a polynomial fitting program are given for the present results and also for all available published data. Linear fits were found to be as good as quadratic and higher-order expressions in this limited energy range. (auth)

16927 ANGULAR CORRELATION MEASUREMENTS IN THE $O^{18}(p,p'\gamma)O^{18}$ REACTION. R. W. Ollerhead, J. S. Lopes, A. R. Poletti, M. F. Thomas, and E. K. Warburton (Nuclear Physics Lab., Oxford). Nucl. Phys., 66: 161-75 (May 1965).

The levels at 3.92, 4.45, 5.09, and 5.25 Mev in ^{18}O were investigated using proton-gamma angular correlation measurements in the $^{18}O(p,p'\gamma)^{18}O$ reaction. The spin of the level at 4.45 Mev was established as one. This level was found to decay 64 ± 5% to the 3.63-Mev 0^+ level and 36 ± 5% to the 1.98-Mev 2^+ level, with an upper limit of 4% placed on the ground state transition. The 3.92-Mev 2^+ level decayed 15 ± 2% to the ground state (0^+), and 85 ± 2% to the 1.98-Mev 2^+ level. The E2/M1 intensity ratio in the 3.92 → 1.98 transition was measured as <8%, with a probable value of 3%. The 5.09- and 5.25-Mev levels were found to decay >90% and 60 ± 8%, respectively, to the 1.98-Mev level, with ground state transitions of <10% and 40 ± 8%. A comparison of levels in ^{18}O with T = 1 levels in ^{18}F was made. (auth)

16928 NEUTRON-PROTON INTERACTION AND l-FORBIDDEN BETA DECAY. Ikuko Hamamoto (Tokyo Univ.). Nucl. Phys., 66: 176-84(May 1965).

Pairing theory is applied to investigate the l-forbidden beta transition of the GT type in odd-mass nuclei. It is found that a small admixture of seniority-3 states to the seniority-1 state is sufficient to explain the observed ft values. The difference between the usual unfavored beta decays and l-forbidden beta decays is discussed within the framework of the present model. It is shown how the various three-quasi-particle states contribute to the matrix elements in the two cases. (auth)

16929 ELASTIC AND INELASTIC SCATTERING OF 150-180 Mev PROTONS FROM ^{12}C. A. B. Clegg (Nuclear Physics Lab., Oxford). Nucl. Phys., 66: 185-92(May 1965).

Measured polarizations in elastic scattering of 150 to 180 Mev protons from ^{12}C are compared with values calculated by assuming that the elastic scattering is due to the first term in the cluster expansion, in which the nucleus is never excited in between the successive collisions of the incident proton with the nucleons of the target nucleus. It is found that there is an important discrepancy between the experimental results and the values calculated from the recent, and more accurate, phase-shift fits to nucleon-nucleon scattering. It is shown how this can perhaps be understood, at least qualitatively, as due to the neglect of a contribution from the second term of the cluster expansion in which the nucleus is excited in one collision and de-excited in a later collision. It is shown how this picture is supported by a comparison of polarization measurements in inelastic scattering exciting the first state of ^{12}C with values calculated by a similar model. (auth)

16930 CONFIGURATION MIXING IN THE Li^6 WAVE FUNCTION. L. R. B. Elton and M. A. K. Lodhi (Battersea Coll. of Tech., London). Nucl. Phys., 66: 209-16(May 1965).

It is shown that configuration mixing in the shell model due to residual two-body interactions is important and, in particular, leads to contributions from core excitations. It is possible to fit the elastic electron scattering data for not too large momentum transfers with a single oscillator parameter and reasonable values for the strength of the residual interaction. (auth)

16931 AN ANTISYMMETRIC FORMULATION OF THE OPTICAL MODEL POTENTIAL AND THE EFFECT OF THE NUCLEAR FORCE RANGE. F. J. Bloore (National Research Council, Ottawa and Univ. of Cambridge, Eng.). Nucl. Phys., 66: 217-29(May 1965).

It is at first sight plausible that the comparatively large range of the N-N force may considerably reduce the central strength of the real part U of the optical potential in light nuclei below the value which obtains inside heavy nuclei. This effect is strongly exhibited in the prescription $U = \langle 0|V|0\rangle$ which arises from a formulation of the scattering problem which treats the incident particle as distinguishable. However, this prescription overestimates U by a factor of 5. An antisymmetric formulation is presented, which suggests a new non-local form for the potential U. In this formulation the factor 5 is removed. This non-local potential is discussed for infinite nuclear matter and for a finite nucleus. A local potential "equivalent" to the non-local potential for the finite nucleus is introduced by means of the Born approximation, but the results are inconclusive. (auth)

16932 NUCLEAR EXCITATION BY 1 Mev TO 3 Mev ELECTRONS. Benson T. Chertok and Edward C. Booth (Boston Univ.). Nucl. Phys., 66: 230-40(May 1965).

A calculation by Robl of the cross section for nuclear excitation by low-energy electrons was tested for states with measured lifetimes in ^7Li, ^{115}In, and ^{111}Cd. The inelastic electron scattering cross section for 3-Mev electrons agrees with theory for the 0.478-Mev states of ^7Li. The total cross sections for electron excitation of ^{115}In and ^{111}Cd was larger than expected by an order of magnitude near threshold. Agreement is obtained if the Robl cross section is multiplied by $F(Z,p)/S_L^{(L)}F(Z,p_0)$ where the Fermi function and $S_L^{(L)}$ are the forbidden beta spectrum shape factor. Photon absorption measurements gave $g\Gamma_0 = 2.9 \pm 0.8 \times 10^{-4}$ ev and $g\Gamma_0 = 1.8 \pm 0.6 \times 10^{-3}$ ev for the 1.07- and 1.46-Mev states of ^{115}In. (auth)

16933 CONTRIBUTIONS OF THE COULOMB FIELD TO THE HIGH PARTIAL WAVES OF THE DEUTERON STRIPPING AMPLITUDE. C. F. Clement (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 66: 241-60(May 1965). (AERE-TP-153)

An analytic and easily calculable form is found for the high partial waves for the case of zero angular momentum transfer. Comparison with distorted-wave Born approximation (DWBA) results for two d-p reactions shows where finite range nuclear effects become negligible. Similarly finite size effects associated with the deuteron do not change the high partial waves. The magnitude of the latter is defined in terms of the asymptotic normalization constants of the transferred neutron in the deuteron and in the nucleus, a model-independent result which is implicit in some previous work. It is argued that all approximate amplitudes, such as DWBA, should reduce to this form for the high partial waves. The asymmetry of the Coulomb force on the deuteron is examined and is shown to have negligible effect if the matrix element containing the neutron-proton interaction is used. On the other hand it must be included in the time-reversed matrix element and the equality between the two cases and its consequences are examined in detail. (auth)

16934 SOFT CORE IN NUCLEAR MATTER CALCULATIONS. H. S. Koehler and Y. R. Waghmare (Univ. of California, San Diego, La Jolla). Nucl. Phys., 66: 261-6(Mar. 1965).

The short-range repulsion in nucleon-nucleon interaction is of importance to obtain saturation of nuclear matter. The repulsive core is usually assumed to be of the form of a hard core. A formal investigation of the effect of replacing this hard core by a soft core was made. The important parameter to estimate the effectiveness of the short-range repulsion is the deficiency in the probability for finding two nucleons close together. This determines the short-range correlations. This parameter also was determined for a set of soft core potentials. The limit of hard core in the light of the soft core potential considered is discussed. The results are compared with those obtained by others for a hard core potential. (auth)

16935 NEUTRON ACTIVATION CROSS-SECTIONS AT 24 kev. A. K. Chaubey and M. L. Sehgal (Muslim Univ., Aligarh, India). Nucl. Phys., 66: 267-72(May 1965).

Neutron activation cross sections were measured for $^{55}Mn(n,\gamma)$, $^{107}Ag(n,\gamma)$, $^{114}Cd(n,\gamma)$, $^{115}In(n,\gamma)$, $^{126}Te(n,\gamma)$, $^{164}Dy(n,\gamma)$, $^{165}Ho(n,\gamma)$, $^{175}Lu(n,\gamma)$, $^{197}Au(n,\gamma)$, and $^{232}Th(n,\gamma)$. An Sb–Be photoneutron source was used for the measurement of the cross sections. The cross sections were measured relative to ^{127}I, whose cross section was taken equal to 0.820 b. The theoretical values of the cross sections are calculated using low-energy resonance parameters. These values are compared with the experimentally measured values, and a good agreement between the two was found. (auth)

16936 RADIATIVE CAPTURE BY EXCITATION OF COLLECTIVE VIBRATIONS. I. THEORY. C. F. Clement (Atomic Energy Research Establishment, Harwell, Berks, Eng.), A. M. Lane, and J. R. Rook. Nucl. Phys., 66: 273-92(May 1965).

Compound nucleus capture falls off rapidly with energy above a few Mev. Observed capture cross sections remain quite large for energies up to 20 Mev or so. A recent paper attempted to explain this discrepancy in terms of a new model of capture, i.e. direct single particle transitions in the nuclear optical potential. However, cross sections calculated with this model are too small by about one order of magnitude. An extension of the model is proposed in which the potential is not restricted to be spherically symmetric, implying that the incident particle is coupled to collective vibrations of the target, particularly the giant dipole resonance. Capture may occur when a target vibration is excited, and the particle enters a bound orbital. Rough estimates indicate that cross sections of about the correct order of magnitude and energy dependence can be achieved. (auth)

16937 RADIATIVE CAPTURE BY EXCITATION OF COLLECTIVE VIBRATIONS. II. CALCULATION. C. F. Clement (Atomic Energy Research Establishment, Harwell, Berks, Eng.), A. M. Lane, and J. R. Rook. Nucl. Phys., 66: 293-6(May 1965).

It is shown that the collective capture mechanism considerably improves the agreement with experiment in the case of proton bombardment of ^{142}Ce. (auth)

16938 THE SPIN OF THE 2 SEC ISOMERIC STATE OF In^{116}. W. Poenitz (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., 66: 297-300(May 1965).

The cross section ratios for the formation of the 2 sec and the 54 min isomeric states of ^{116}In due to neutron capture in the three lowest resonances of the ^{116}In compound nucleus were measured. A comparison of the results with the isomeric cross section ratios calculated by the γ-ray cascade statistics yields for the spin of the 2 sec state, a value $J_{m2} = 5$. The activation cross section for thermal neutrons was calculated from the isomeric cross section ratio in the 1.46 ev resonance to be $\sigma_{m2}(0.0253\ ev) = 81 \pm 8$ b. (auth)

16939 POLARIZATION OF NEUTRONS FROM THE $T(d,n)He^4$ REACTION AT 0.6 AND 1.2 Mev. F. Boreli, V. Lazarevic, and N. Radisic (Inst. "Boris Kidrich," Belgrade). Nucl. Phys., 66: 301-4(May 1965).

Polarization of neutrons from the $T(d,n)^4He$ reaction at 0.6 and 1.2 Mev incident deuteron energies was measured. At an angle of 30°(lab) values of P_n of -0.03 ± 0.02 and -0.04 ± 0.02 respectively, were obtained. Helium gas in a specially constructed coincident arrangement was used. Alpha recoils registered in a proportional counter and two ZnS/Ag scintillation detectors made possible the measurement of the left/right asymmetry ratio. (auth)

16940 ELECTRIC QUADRUPOLE TRANSITIONS AND RENORMALIZATION OF INTERACTIONS IN SPHERICAL NUCLEI. R. Arvieu (Laboratoire de Physique Nucleaire, Orsay, France) and E. Salusti. Nucl. Phys., 66: 305-22 (May 1965). (In French)

The calculation of quadrupole transitions in even Sn, Pb, and Ni isotopes was performed by using a finite range force and either the Tamm-Dancoff approximation or the random phase approximation. The results are compared with those obtained by using a quadrupole force. The problem of the effective charge is discussed. The various effects of the configuration mixing are separated and discussed. It is found that the main difference between the gaussian interaction used in earlier publications and the quadrupole force lies in the effects of these two forces in the RPA. (auth)

16941 HALF-LIFE MEASUREMENT OF THE 26.8 kev LEVEL IN I^{129}. S. C. Pancholi (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., 66: 323-4(May 1965).

The half life of the 26.8-kev level in ^{129}I was measured by the delayed coincidence (logarithmic slope) method and is found to be $T_{\frac{1}{2}} = 16.4 \pm 1.1$ ns in good agreement with earlier measurements. (auth)

16942 EXCITED LEVELS OF Ho^{166}. M. K. Balodis, V. A. Bondarenko, P. T. Prokofiev, and L. I. Simonova (Inst. of Physics, Riga). Nucl. Phys., 66: 325-31(May 1965).

The internal conversion electron spectrum in the reaction $^{165}Ho(n,\gamma)^{166}Ho$ was measured with a β spectrograph. Within the energy interval 40-300 kev, energies and intensities of conversion electron lines were determined. The scheme of low-energy levels in ^{166}Ho is discussed. The characteristics 3^-, 4^- are proposed for the levels at 170.6 and 240.1 kev instead of assignments existing in the literature. (auth)

16943 POLARIZATION EFFECT IN POSITON BACKSCATTERING. A. Bisi, A. Fiorentini, and L. Zappa (Istituto di Fisica del Politecnico, Milan). Nucl. Phys., 66: 332-6(May 1965).

The polarization of positrons from a β^+ emitter just prior to capture in a positronium atom was measured in Teflon with different metal backings, by analyzing the time annihilation spectra in the presence of a magnetic field. It was found that the polarization decreases with increasing atomic number Z of the backing. In the limit of very low Z it attains a value compatible with what would be expected in the extreme assumption of absence of any depolarizing processes. At high Z the polarization of the backscattered beam appears to be reversed if compared with that of the direct beam. (auth)

16944 NUCLEAR LEVELS OF ^{56}Co FROM THE DECAY OF ^{56}Ni. Hajime Ohnuma, Yoshio Hashimoto, and Isao Tomita (Tokyo Univ.). Nucl. Phys., 66: 337-57(May 1965).

The decay of ^{56}Ni is investigated to study lower excited states in the ^{56}Co nucleus. From measurements of internal conversion electrons and angular-correlation functions for all coincident gamma ray pairs, unique spin and parity assignments are obtained as follows: 163-kev level, 3^+; 975-kev level, 2^+; 1.45-Mev level, $1(2)^-$; 1.72-Mev level, 1^+. Multipole mixtures of transitions between these levels are also determined. Results are discussed on the basis of the jj coupling shell model with p–n interactions. (auth)

16945 NOTE ON APPROXIMATIONS TO NON-LOCAL NUCLEAR INTERACTION. W. E. Frahn (Univ. of Cape Town). Nucl. Phys., 66: 358-60(May 1965).

Perey and Saxon have recently suggested an approximation to nonlocal interactions by expanding the Fourier transform of the nonlocal form factor about a finite parameter κ^2. It is shown that this approximation leads to a gen-

eralized effective mass equation, that the parameter κ should be identified with the local wave number associated with the equivalent local potential, and that the Perey-Saxon approach is closely related to the local approximation of Perey and Buck. (auth)

16946 INVESTIGATION OF THE NUCLEAR SURFACE BY MEANS OF (n,α) REACTIONS. W. Osakiewicz, J. Turkiewicz, Z. Wilhelmi, and M. Jaskola (Inst. of Nuclear Research, Warsaw and Univ. of Warsaw). Nucl. Phys., 66: 361-4(May 1965).

The use of the (n,α) reactions as a tool for investigating the nuclear surface is proposed. Conclusions are drawn about the probability of finding alpha substructures at the surface of ^{139}La nuclei. (auth)

16947 ENERGY LEVELS FROM ELECTRON CONVERSION IN Pb^{207}. F. P. Brady, N. F. Peek, and R. A. Warner (Univ. of California, Davis). Nucl. Phys., 66: 365-8(May 1965).

The transition energies and lowest energy levels of ^{207}Pb were determined with some precision by observing the internal conversion electrons following the decay of ^{207}Bi. The transition energies are 569.62 ± 0.06, 897.29 ± 0.30, 1063.44 ± 0.09, 1769.71 ± 0.13 kev; and the energies of the levels are 569.62 ± 0.06, 897.29 ± 0.30, 1633.06 ± 0.11 and 2339.33 ± 0.14 kev. (auth)

16948 THE $B^{11}(He^3,\alpha)B^{10}$ REACTION BETWEEN 2.2 AND 5.5 Mev. P. D. Forsyth, I. J. Taylor, and R. R. Perry (Rice Univ., Houston, Tex.). Nucl. Phys., 66: 376-90(May 1965). (TID-21260)

The differential cross sections for the $^{11}B(^3He,\alpha)^{10}B$ reactions leading to the ground state of ^{10}B and to excited states at 0.72, 1.74, and 2.15 Mev were measured as a function of bombarding energy between 2.2 and 5.5 Mev at laboratory angles of 15, 90, and 165°. Angular distributions were measured at bombarding energies of 2.35, 2.86, 3.42, 3.93, 4.50, 5.02, and 5.51 Mev. The total cross sections for these reactions were obtained by integration of the angular distributions. The small variation of the angular distributions with energy and the strong forward peaking at the higher energies suggest that a direct interaction mechanism predominates. A comparison with the $^{11}B(p,d)^{10}B$ and $^{11}B(d,t)^{10}B$ reactions indicate that this mechanism is probably pick-up. There is some evidence for a compound nucleus contribution in the case of the reaction which leaves ^{10}B in its second excited state at 1.74 Mev. (auth)

16949 THE DECAY OF Mo^{99}. T. Cretzu and K. Hohmuth (Zentralinstitut fur Kernforschung, Rossendrof, Ger.). Nucl. Phys., 66: 391-400(May 1965). (In German)

The decay of ^{99}Mo was investigated using a scintillation spectrometer, a magnetic beta spectrometer, and a two-dimensional coincidence arrangement. In coincidence with the 370-kev gamma ray, two new gamma transitions with energies of 410 and 620 kev were found. The 1131-kev level in ^{99}Tc was confirmed by measuring coincidences between 181 and 950 kev gamma rays, the latter of which was not secured formerly. Furthermore, in coincidence with 950-kev gamma rays a new beta branch with energy 245-kev was observed. Other branches supposed to go to the ground state of ^{99}Tc and to a level of 740 or 780 kev were not detected. The relative intensities of the gamma rays were determined by analyzing the measured spectra by means of standard line shapes. A decay scheme of ^{99}Mo is proposed. (auth)

16950 LIFETIMES OF EXCITED STATES IN Cu^{63}, Cu^{65}, Ni^{62}, AND Fe^{56} BY DOPPLER SHIFT ATTENUATION MEASUREMENTS. M. A. Eswaran, H. E. Gove, A. E. Litherland, and C. Broude (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 66: 401-18(May 1965).

The lifetimes of the first three excited states in ^{63}Cu and ^{65}Cu and the first excited states in ^{62}Ni and ^{56}Fe were measured by the Doppler shift attenuation method; the states were Coulomb excited using a beam of oxygen ions from a tandem accelerator. The mean lifetimes of the 0.668, 0.961, and 1.327-Mev states in ^{63}Cu were found to be 3.3, 9.6, and 8.3 in units of 10^{-13} sec. Those of the 0.770, 1.114 and 1.482-Mev states in ^{65}Cu were found to be 1.3, 5.3, and 7.6 in units of 10^{-13} sec. For the 1.172-Mev state in ^{62}Ni and 0.845-Mev state in ^{56}Fe the mean lifetime values obtained were 2.26 and 11.3 in units of psec. The results for the levels in the copper isotopes are compared with the predictions of the core excitation model. (auth)

16951 ON THE EXCITATION CROSS SECTIONS OF SOME (n,α) AND (n,2n) REACTIONS FOR 14 Mev NEUTRONS. A. Peil (Ehemaliges Kernphysikalisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Nucl. Phys., 66: 419-28(May 1965). (In German)

The cross section for the (n,α) reactions in ^{31}P, ^{39}K, ^{44}Ca, and ^{55}Mn and for the ^{39}K(n,2n) reaction was measured by the activation method. The measurements were made at a neutron energy of 14.5 ± 0.4 Mev. The experimental results are compared with previously published values. (auth)

16952 EXPERIMENTAL EVIDENCE FOR NUCLEAR DEFORMATION PARAMETERS. Shinzo Nakai (Duke Univ., Durham, N. C.). Nucl. Phys., 66: 429-32(May 1965).

It is shown that the relation found by Sheline for even deformed nuclei and the successful account for many energy levels by Davydov-Filippov theory are due to special correlations between assigned values of deformation parameters. (auth)

16953 VARIATION OF THE STRENGTH FUNCTION WITH THE SPIN VALUE. J. Julien, S. de Barros, V. D. Huynh, G. le Poittevin, J. Morgenstern, F. Netter, and C. Samour (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., 66: 433-8(May 1965). (In French)

The total neutron cross section was investigated for natural bromine from 100 up to 2000 ev. Resonance parameters and spin values are given for many levels. As in neighboring nuclei (^{75}As, Ga) the strength function for the spin value J = 2 is twice that for J = 1. This strength function dependence is discussed for different nuclei investigated at Saclay and the significant results are summarized. (auth)

16954 BETA SPECTRA FROM THE DECAY OF Pr^{143} AND P^{32}. B. Persson and J. Reynolds (Univ. of Lund, Sweden). Nucl. Phys., 66: 439-48(May 1965).

The beta spectra of ^{143}Pr and ^{32}P were measured using solid state detectors in approximately 4π geometry. Deviations from the statistical shape are small, if any. (auth)

16955 THE INFLUENCE OF THE PAULI EXCLUSION PRINCIPLE ON THE MOMENT OF INERTIA OF STRONGLY DEFORMED NUCLEI. Chi-yu Hu (California State Coll., Long Beach). Nucl. Phys., 66: 449-64(May 1965).

The Peierls formula for the moment of inertia is investigated under the Hartree-Fock approximation. It is found that the Peierls formula can be reduced to the Inglis formula approximately when the exchange terms of the interaction matrix elements are neglected. These exchange terms are found negligible only when the interaction is of a long-range character. In the limit of a δ function interaction, the Peierls moment of inertia reduces to less than one-half of the Inglis value. (auth)

16956 CHARGED PHOTOPARTICLES FROM ARGON. M. A. Reimann, J. R. MacDonald, and J. B. Warren (Univ. of British Columbia, Vancouver). Nucl. Phys., 66: 465-71 (May 1965).

Charged photoparticles from ^{40}Ar were observed in a gridded ionization chamber irradiated with 9.17- and 17.71-Mev gamma rays. Partial and total cross sections are given for the reactions $^{40}Ar(\gamma,p)^{39}Cl$ and $^{40}Ar(\gamma,\alpha)^{36}S$. (auth)

16957 DECAY OF $^{99}Mo-^{99m}Tc$. Peter Crowther and J. S. Eldridge (Oak Ridge National Lab., Tenn.). Nucl. Phys., 66: 472-80(May 1965). (ORNO-P-518)

The decay parameters of $^{99}Mo-^{99m}Tc$ were determined using liquid-liquid extractions, $4\pi\beta$-γ and $\gamma-\gamma$ coincidence counting, and absolute gamma-spectroscopy measurements. Gamma energies and intensities were obtained with a

7.6 cm × 7.6 cm NaI(Tl) spectrometer. The relative intensities of the 0.74 and 0.78-Mev gamma rays were measured using a lithium ion-drifted germanium detector (these peaks were unresolved in the NaI(Tl) spectra). The observed number of gamma photons per ^{99}Mo disintegration with energies of 0.93, 0.780, 0.740, 0.372, 0.181, and 0.142 Mev was found to be 0.004, 0.044, 0.124, 0.013, 0.068, and 0.076, respectively. Gamma-gamma coincidence measurements confirmed the 0.93-Mev gamma ray in the ^{99}Mo decay. A quantitative separation of ^{99m}Tc followed by x- and gamma-ray emission rate determinations gave the sum of the internal conversions of the 0.142 and 0.140-Mev gamma rays as $\alpha_T = 0.099 \pm 0.015$. At equilibrium the ^{99m}Tc daughter activity was determined to be 0.964 that of the ^{99}Mo activity. (auth)

16958 MEASUREMENTS OF (n,γ) EFFECTIVE CROSS SECTIONS AND RESONANCE INTEGRALS WITH A LEAD SPECTROMETER. F. Mitzel and H. S. Plendl (Kernforschungszentrums, Karlsruhe, Ger.). Nukleonik, 6: 371-9(Dec. 1964). (In German)

A slowing-down time spectrometer, which was first described by Bergmann, Isakoff, and Shapiro, was used to determine (n,γ) effective cross sections in dependence on the energy resonance integrals and resonance parameters. The measurements were made at mean neutron energies from 1 ev to 30 kev. The energy resolution capacities were about 20%. Mo, Fe, and Ag were investigated. (tr-auth)

16959 INVESTIGATIONS ON THE ENERGY DEPENDENCE OF THE BACK-SCATTERING FACTORS OF BETA RADIATION WITH A SCINTILLATION COUNTER. H.-W. Thuemmel and V. Krivan (Institut für Angewandte Radioaktivitat, Leipzig). Nukleonik, 6: 379-84(Dec. 1964). (In German)

In correspondence with the experiments with monoenergetic electrons, the back-scattering factors of beta radiation should also decrease with increasing primary or maximum energy; this could be detected by measurements with a scintillation counter. The advantages and disadvantages of the introduction of the scintillation measurement method for back-scattering factor measurements were discussed. (tr-auth)

16960 RADIATION LENGTH IN NUCLEAR EMULSIONS. R. K. Puri and Prem K. Aditya (Indian Inst. of Tech., New Delhi). Nuovo Cimento (1), 2: Suppl., 336-41(1964).

An attempt was made to determine the radiation length in nuclear emulsions. The principle of the experimental measurement consisted of measuring the average value E_x/E_0 for a large sample of monoenergetic electrons as a function of the distance X traversed. G-5 nuclear emulsions exposed to electrons at (800 ± 70) Mev. (C.E.S.)

16961 THE PRESENT STATUS OF PHOTONEUTRON CROSS-SECTION MEASUREMENTS. B. M. Spicer (Univ. of Melbourne). Nuovo Cimento (1), 2: Suppl., 243-75(1964).

A review is given of attempts to measure photoneutron cross sections. Discrepancies in various experimental results are discussed, and the factors that enter the absolute determination of a photoneutron cross section are considered. These factors are discussed with particular reference to the experimental arrangements used in the measurements. Evaluations of some of the factors are made, and approximate corrections are given. (C.E.S.)

16962 IMAGINARY PART OF THE Λ OPTICAL POTENTIAL IN NUCLEAR MATTER. B. W. Downs, Budh Ram, and W. E. Ware (Oxford Univ.). Nuovo Cimento (10), 35: 852-9(Feb. 1, 1965).

The depth of the imaginary part of the optical potential in nuclear matter is calculated for incident Λ particles having laboratory energies less than 80 Mev with an assumed real well 35 Mev deep. This imaginary depth exceeds that for incident neutrons for low energies, being several times as large at zero energy. For the intermediate and higher energies considered, the depth for Λ's is estimated to be less than that for neutrons. Surface absorption in finite nuclei is expected to be relatively less important for incident Λ's than for incident nucleons. (auth)

16963 LINEAR POLARIZATION OF ELASTIC SCATTERING OF 662 kev γ-RAYS. M. Singh, S. Anand, and B. S. Sood (Punjabi Univ., [Chandigarh, India]). Nuovo Cimento (10), 35: 1047-51(Feb. 16, 1965).

Measurements of the linear polarization of 662-kev gamma-rays elastically scattered from lead are reported. Special care was taken to isolate elastic scattering from inelastic scattering. The experimental results are found to agree well with the refined calculations of Brown and Mayers and to contradict the earlier form factor calculations. (auth)

16964 RADIATIVE MUON CAPTURE FROM NUCLEI. E. Borchi (Universita, Florence). Nuovo Cimento (10), 35: 1077-1104(Feb. 16, 1965).

The radiative capture of mesons (μ^-) on nuclei and on liquid hydrogen is analyzed, using an interaction that includes an induced tensorial coupling from the second class of currents as well as the standard couplings from the first-class currents. (D.C.W.)

16965 ON THE GREEN'S FUNCTION METHOD FOR SYSTEMS WITH A FIXED ANGULAR MOMENTUM. D. Prosperi (Centro di Studi Nucleari della Casaccia, Rome and Scuola di Perfezionamento in Fisica Nucleare, Rome) and E. Salusti. Nuovo Cimento (10), 35: 1194-1210 (Feb. 16, 1965).

The Green's function formalism was applied to systems with a fixed angular momentum, such as atomic nuclei. A system of coupled equations describing single-particle states was obtained. The feasibility of linearization of the equation of motion for these particular Green's functions was critically examined. A method to construct perturbatively a self-consistent central potential, which synthesizes the interactions among nucleons, was obtained. This method was applied to study the low-energy spectrum of ^{115}Sn and ^{117}Sn. Reasonable agreement with the experimental data was found. (auth)

16966 STUDY OF HYPERFRAGMENTS. I. HYPERFRAGMENTS PRODUCED BY 3.5 Gev/c PIONS. S. N. Ganguli, N. K. Rao, and M. S. Swami (Tate Inst. of Fundamental Research, Bombay). Nuovo Cimento(10), 36: 35-49(Mar. 1, 1965).

A total of 210 hyperfragments, produced in interactions of 3.5-Bev/c pions with emulsion nuclei were analyzed in detail. The results provide strong evidence that an appreciable fraction ($\gtrsim$35%) of short hyperfragments (ranges $\leq$10 μm) have masses $\lesssim$50 times that of a nucleon. The ratio of nonmesonic to π^--mesonic decays is found to be $\lesssim$1.4 for He hyperfragments, ~12 for Li hyperfragments and ~140 for short hyperfragments. The decay of Λ via a virtual Σ-state appears to be important. (auth)

16967 THE STUDY OF SHORT-RANGE HYPERFRAGMENTS— THE PRODUCTION. A. W. Key, S. Lokanathan, and Y. Prakash (Oxford Univ.). Nuovo Cimento (10), 36: 50-66(Mar. 1, 1965).

The production features of the short range ($R \leq 10$ μm) hyperfragments produced from the interactions of 800, 1500, and 3500-Mev/c mesons (K^-) in emulsions are studied. The results are compared with the range and mass distributions obtained from a Monte Carlo calculation. It is observed that while the observed and calculated range spectra agree well for the hyperfragments of range >3 μm, an observational loss of about 50% is predicted for those of range <3 μm. A large variation in the masses of such hyperfragments, viz. A ~ 25 to 95, is predicted. (auth)

16968 HYPERFINE-STRUCTURE SEPARATIONS AND MAGNETIC MOMENTS OF GOLD-194, 195, AND 196. Yau Wa Chan, W. Bruce Ewbank, William A. Nierenberg, and Howard A. Shugart (Univ. of California, Berkeley). Phys. Rev., 137: B1129-33(Mar. 8, 1965). (UCRL-11586)

The hyperfine-structure separations in the $^2S_{\frac{1}{2}}$ electronic

ground state of 39-hr ^{194}Au, 185-day ^{195}Au, and 6.2-day ^{196}Au were measured by the atomic-beam magnetic-resonance method. From these measurements combined with the known constants of ^{197}Au, the corresponding nuclear magnetic-dipole moments were calculated by means of the Fermi-Segrè formula. A 5% error is assigned in these moments to include a possible hyperfine-structure anomaly correction. (auth)

16969 THEORY OF FINITE NUCLEI. H. S. Koehler (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: B1145-57(Mar. 8, 1965).

A shell-model potential is defined for calculations on the structure of finite nuclei by the reaction-matrix theory. The rearrangement potential is part of this shell-model potential. The contribution to the rearrangement energy from the short- and long-range parts of the nucleon-nucleon potential is calculated in infinite nuclear matter. The third-order rearrangement term is shown to be predominantly due to the strong short-range part, while the second-order term comes mainly from the long-range part. The dependence of the reaction matrix on the structure of the nuclear medium in which the nucleons interact is investigated. The results from the calculations of rearrangement energies is then of help. Part of the short-range repulsion is proportional to the reaction-matrix potential energies of the interacting nucleons. Another part is a function of the "local" density. The long-range part of the reaction matrix varies somewhat less with the density of an infinite system than does the short-range part. It seems, however, that it would be important to include its dependence on the medium, especially for studying small nuclei or the structure of the surface. (auth)

16970 SPIN, HYPERFINE STRUCTURE, AND NUCLEAR MAGNETIC DIPOLE MOMENT OF 23-SEC Na^{21}. O. Ames, E. A. Phillips, and S. S. Glickstein (Princeton Univ., N. J.). Phys. Rev., 137: B1157-63(Mar. 8, 1965). (PUC-1964-151)

The spin and hyperfine structure of 23-sec ^{21}Na, the mirror nucleus to ^{21}Ne, were measured by the atomic-beam magnetic-resonance technique. The ^{21}Na was produced by the reaction $^{24}Mg(p,\alpha)^{21}Na$. The target material in the form of a powder was bombarded in an oven in the resonance apparatus. If the oven was heated to about 450°C, the ^{21}Na escaped from the Mg in sufficient quantity to make a useful atomic beam. Both $\Delta F = 0$ and $\Delta F = 1$ resonances were observed, and the final values are $I = 3/2$, $\Delta\nu = 1906.466 \pm 0.021$ Mc/sec. Comparison with ^{23}Na yields $\mu_I = 2.386\ 12 \pm 0.000\ 10$ nm (diamagnetically corrected). The results are discussed in terms of the current nuclear theories. (auth)

16971 MEAN LIVES OF EXCITED ROTATIONAL STATES OF HEAVY EVEN-EVEN NUCLEI. W. R. Neal and H. W. Kraner (Massachusetts Inst. of Tech.; Cambridge). Phys. Rev., 137: B1164-74(Mar. 8, 1965).

The lifetimes of the 2+ and 4+ excited states of the ground-state rotational band of three even-even nuclides ^{224}Ra, ^{228}Th, and ^{230}Th in the rotational region beyond Pb and the 2+ first excited state of a nearby vibrational nuclide (^{220}Rn) were measured by delayed-coincidence techniques. The alphas to the excited state were detected with a semiconductor charged-particle detector, and the conversion electrons from the de-exciting state were detected with a plastic scintillator. The full width at half maximum of the resulting prompt spectrum was 0.5 nsec, with a limiting equivalent half-life of 60 psec. A system of multiple Peieris analyses was carried out to obtain the best lifetime values, which are presented, along with the ratio of the reduced E2 transition probabilities in the case of rotational nuclides. The ratios of the reduced transition probabilities are quite close to the value of 1.43 predicted by the collective model. (auth)

16972 THERMAL AND RESONANCE NEUTRON CAPTURE IN COPPER, NICKEL, AND MANGANESE. O. A. Wasson and J. E. Draper (Yale Univ., New Haven). Phys. Rev., 137: B1175-81(Mar. 8, 1965).

The high-energy γ rays following low-energy ($E_n < 10$ kev) neutron capture in Cu, Ni, and Mn were observed with a NaI(Tl) anticoincidence spectrometer. Large fluctuations in the intensities of ground-state transitions of the two Cu isotopes were observed. The relative intensities of the high-energy transitions in both Ni and Cu decrease significantly with neutron energy at only ~1 kev. The variations of the twelve highest energy transitions for the three lowest energy resonances in Mn were measured. The 7.04-Mev transition varied by a factor of 25, while the rest showed much less fluctuation. None of the twelve transitions is appreciably correlated with the reduced neutron width. (auth)

16973 INELASTIC NEUTRON SCATTERING NEAR THRESHOLD. A. B. Tucker, J. T. Wells, and W. E. Meyerhof (Stanford Univ., Calif.). Phys. Rev., 137: B1181-7 (Mar. 8, 1965).

Cross sections for the production of excited states by neutron inelastic scattering were measured as a function of bombarding energy from 0 to 300 kev above threshold for the first two excited states of ^{56}Fe, the first two excited states of ^{63}Cu, the first excited state of ^{90}Zr, the first two excited states of ^{138}Ba, and the first three excited states of ^{140}Ce. Neutron-beam energy resolution was 10–20 kev. Inelastic-scattering events were counted by detecting gamma rays from the excited states. When the number of open channels for compound-nucleus decay is small, (a condition which exists near threshold for exciting low-lying states) fluctuations of reaction widths about their average values reduce the inelastic-scattering cross section from that predicted by the Hauser-Feshbach equation by as much as 50%. This correction was evaluated, assuming a Porter-Thomas distribution of widths. Good agreement was found between experimental cross sections and the modified Hauser-Feshbach equation in all but two cases. (auth)

16974 EXCITATION FUNCTIONS, RECOIL RANGES, AND STATISTICAL THEORY ANALYSIS OF REACTIONS INDUCED IN Fe^{56} WITH 6-29-Mev He^3 IONS. Jean-Pierre Hazan and Marshall Blann (Univ. of Rochester, N. Y.). Phys. Rev., 137: B1202-13(Mar. 8, 1965).

Excitation functions and integral recoil ranges were measured for products of the (^{3}He,p), (^{3}He,pn), (^{3}He,p2n), (^{3}He,2n), and (^{3}He,3n) reactions of ^{56}Fe. The ^{3}He kinetic energies varied between 6 and 29 Mev. Targets were 99.7% enriched ^{56}Fe, electroplated on 0.2-mil gold foils. The experimental recoil ranges of reaction products formed between the corresponding reaction thresholds and excitation function peaks are compared with the ranges predicted by the theory of Lindhard, Scharff, and Schiøtt; the ranges are in agreement with the theoretical predictions within the ± 10% uncertainty of the experimental measurements. With the exception of the ^{57}Co ranges resulting from ^{3}He ion bombardment at energies greater than 25 Mev, all ranges are consistent with a predominantly full-momentum-transfer mechanism with 90° symmetry for emitted particles. The sensitivity of the experimental ranges to reaction mechanism is discussed, as is the influence on range of nucleon evaporation. The excitation functions for the production of ^{56}Ni, ^{56}Co, ^{57}Ni, ^{57}Co, and ^{58}Co were compared with three sets of statistical-theory calculations. The first set of calculations was a conventional Weisskopf evaporation calculation in which a level density of the form $\rho(E,J) \propto (2J+1)E^{-2}\exp[2(aE)^{1/2}]$ was used. The calculated excitation functions attained their maximum yields at lower energies than the corresponding experimental excitation functions, as had been noted for similar calculations for ^{4}He-induced reactions of ^{56}Fe and ^{58}Ni. A correlation is shown to exist between the displacement of calculated and experimental excitation functions and average rotational energy for the three systems. In the second set of calculations a level density of the form $\rho(E,J) \propto (2J+1)(E-E_{ROT})^{-2}\exp\{2[a(E-E_{ROT})]^{1/2}\}$ was used, where $E_{ROT} = J(J+1)\hbar^2/2\,I_{RIG}$, and I_{RIG} is the rigid-body moment of inertia. Evaporation probabilities were summed for each impact parameter J, weighted as $(2J+1)T_J$, where T_J is the transmission coefficient for a ^{3}He ion introducing J units of orbital angular momentum. Transmission coefficients were calculated with the nuclear optical model. It was assumed that all rotational energy

was dissipated by γ-ray deexcitation. The second set of calculated excitation functions was in better agreement with experimental values with respect to the positions of maxima on the energy axis. In the third set of calculations, a level density of the form $\rho(E,J) \propto (2J+1)(E+\Delta E)^{-2}\exp\{2[a(E+\Delta E)]^{\frac{1}{2}}\}$ was used, where ΔE was a shift in energy calculated according to the model of Rosenzweig in order to approximate the influence of shell occupation on level densities. Ratios of yields of $^{56}Co/^{56}Ni$ and $^{57}Co/^{57}Ni$ calculated in the third set of calculations were in approximately an order of magnitude better agreement with experimental values than the results of the first set of calculations. Energies used in all calculations were corrected for pairing effects using the masses of Everling. Optical-model nonelastic cross sections were used for inverse-reaction cross sections, and the level spacing parameter a was evaluated from ^{56}Fe (^3He,p) proton spectra. (auth)

16975 MÖSSBAUER EFFECT IN Dy^{160}. R. L. Cohen (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 137: A1809-13(Mar. 15, 1965).

The Mössbauer effect was used to study the hyperfine structure of ^{160}Dy in various materials. Using $Dy:Fe_2Tb$, the magnetic moment of the 2^+ state of ^{160}Dy was determined to be 0.74 nm. The absorption spectrum in DyIG shows that there are two sites for the Dy ions, with magnetizations of 6.9 and 8.4 μ_B. Magnetic hyperfine structure was observed in paramagnetic Dy_2O_3, and a preliminary analysis of the spectrum was made; there is some general discussion of the interpretation of hyperfine structure in paramagnets. The results are compared with other measurements, particularly in ^{161}Dy. (auth)

16976 KNIGHT SHIFT ANISOTROPY IN SCANDIUM AND YTTRIUM AND NUCLEAR QUADRUPOLE COUPLING IN SCANDIUM. R. G. Barnes, F. Borsa, S. L. Segel, and D. R. Torgeson (Ames Lab., Ames, Iowa). Phys. Rev., 137: A1828-34(Mar. 15, 1965). (IS-1002)

The anisotropic Knight shift of the ^{45}Sc and ^{89}Y nuclear magnetic resonances (NMR) in polycrystalline scandium and yttrium metal, respectively, was observed and measured at room temperature by means of the magnetic field dependence of the $\frac{1}{2} \rightleftharpoons -\frac{1}{2}$ transition. The isotropic Knight shift, K_{iso}, is (0.262 ± 0.002) % for scandium and (0.367 ± 0.005) % for yttrium. The axial component of the Knight shift, K_{ax}, is −(0.024 ± 0.002) % for scandium and −(0.026 ± 0.002) % for yttrium. The scandium NMR spectrum contains a central transition and three pairs of satellite lines, consistent with the I = $\frac{7}{2}$ spin of ^{45}Sc. The average spacing of the three pairs of satellites yields a lowest pure quadrupole frequency, ν_Q = 0.144 ± 0.002 Mc, so that the quadrupole coupling, e^2Qq/h = 2.02 ± 0.03 Mc. Analysis of the central transition splitting yields the same value within the experimental uncertainty. (auth)

16977 LIFETIMES OF 1^- STATES IN Sm^{148} AND Sm^{152}. F. R. Metzger (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 137: B1415-20(Mar. 22, 1965).

Sources of $(^{148}Pm)_2O_3$ and $(^{152}Eu)_2O_3$, moving at the high linear velocities available with ultracentrifuges, provided the resonant gamma radiation for the excitation of the 1.46-Mev 1^- level in ^{148}Sm and the 0.96-Mev 1^- level in ^{152}Sm. The partial width Γ_0 for the 0.96-Mev E1 ground-state transition in ^{152}Sm was determined in a self-absorption experiment as $\Gamma_0 = (7.3 \pm 0.6) \times 10^{-3}$ ev. With a branching ratio $\Gamma_{0.96}/\Gamma_{0.84} = 0.77$, this leads to a mean life τ_{level} (0.96 Mev) = $(3.9 \pm 0.4) \times 10^{-14}$ sec. The scattering data from ^{148}Sm were analyzed, using slowing-down information obtained from a study of the shape of the 0.96-Mev ^{152}Sm emission line, and a mean life τ_{level} (1.46 Mev) = $(1.4^{+0.9}_{-0.3}) \times 10^{-13}$ sec was obtained. These results show that the E1 transitions from the 1^- states in ^{148}Sm and ^{152}Sm are considerably retarded, the retardation for the transitions in the spherical nucleus ^{148}Sm being almost 1 order of magnitude larger than that for the E1 transitions in the deformed nucleus ^{152}Sm. (auth)

16978 ALPHA CLUSTERS IN A HARMONIC-OSCILLATOR POTENTIAL. F. C. Chang (St. John's Univ., Jamaica, N. Y.). Phys. Rev., 137: B1420-3(Mar. 22, 1965).

The probabilities of occurrence of alpha clusters are calculated for the case of four nucleons in a harmonic-oscillator potential, based on the simplifying approximation that the oscillator constants for alpha clusters and nucleons are equal. Some general observations as to how alpha-decay hindrance is affected by the overlap of wave function of a cluster and that of the constituent nucleons are made. The decay of ^{211}Po is discussed in part. (auth)

16979 DECAY OF LONG-LIVED Ho^{166}. C. W. Reich and J. E. Cline (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 137: B1424-37(Mar. 22, 1965). (TID-21227)

The gamma radiation following the decay of the long-lived ^{166}Ho activity was studied using lithium-ion drifted germanium counters and NaI(Tl) scintillation detectors. In addition to providing more precise energy measurements for many of the transitions than was possible earlier, the higher resolution of the germanium detector revealed that two of the previously reported high-energy gamma rays are doublets. Thus, the level previously reported at 1680 kev was revealed as two levels, separated by 26 kev. Gamma-gamma coincidence studies have revealed the existence of transitions having energies of 96, 122, 137, and 163 kev which excite these two levels. Gamma-gamma directional correlation measurements were carried out on prominent cascades. The results of the correlations confirm the spins previously reported. The existence of levels in ^{166}Er having the following energies in kev and spin and parity assignments is proposed: 0, 0+; 90, 2+; 265, 4+; 544, 6+; 787, 2+; 861, 3+; 910, 8+; 957, 4+; 1074, 5+; 1215, 6+; 1374, 7+; 1662, 5−; 1688, 5−; 1784, 6−; and 1825, 6−. The gamma-ray relative intensities indicate that there is no appreciable beta feeding of the two 5− states. The mixing-ratio parameters δ for the interband transitions of 529, 830, and 810 kev are all positive and large. For the first two of these, the M1 admixture is less than 0.1%, while for the last, it is about 0.1%. An interpretation of the properties of the positive-parity states is given in terms of the strong-coupling nuclear model with band mixing and in terms of a generalized asymmetric-rotator model. Possible interpretations of the nature of the negative-parity states are presented. (auth)

16980 LEVEL SHIFTS OF SHELL-MODEL STATES IN THE CONTINUUM. W. M. MacDonald (Univ. of Maryland, College Park). Phys. Rev., 137: B1438-41(Mar. 22, 1965).

A unified theory of nuclear reactions was given in which shell-model states are rigorously incorporated as states of the compound nucleus. Shell-model states above the particle emission threshold are given a clear interpretation; the calculation of resonance energies and level widths from them is clearly defined. The level shifts resulting from the interactions of these states with the continuum are discussed, and shown to have been mostly included in the usual shell-model calculations. Limits on a residual shift due to damping are derived and evaluated for the giant resonance levels in ^{16}O. (auth)

16981 GAMMA RAYS FROM THE LOW-LYING LEVELS OF F^{18}. C. Chasman, K. W. Jones, R. A. Ristinen, and E. K. Warburton (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B1445-7(Mar. 22, 1965). (BNL-8540)

A 5-mm-thick lithium-drifted germanium counter was used to detect the low-energy gamma rays (Eγ < 1.8 Mev) emitted at 90° to the beam following bombardment of an ^{16}O gas target with ^3He ions with a mean energy of 1.8 Mev. The excitation energies of the first seven levels of ^{18}F were determined to ±2 kev or better from energy measurements of the de-excitation gamma rays from these levels. The decay of the ^{18}F 2.10-Mev level to the 0.94- and 1.08-Mev levels was confirmed, and an upper limit of 6% was placed on the branch to the 1.045-Mev level. (auth)

16982 ALPHA-DECAY PROPERTIES OF SOME LUTETIUM AND HAFNIUM ISOTOPES NEAR THE 82-NEUTRON CLOSED SHELL. Ronald D. MacFarlane (McMaster Univ., Hamilton, Ont., Can. and Univ. of California, Berkeley). Phys. Rev., 137: B1448-52(Mar. 22, 1965). (UCRL-11652)

The 84- and 85-neutron isotopes of lutetium, ^{155}Lu and ^{156}Lu, and the 85- and 86-neutron isotopes of hafnium, ^{157}Hf

and ^{180}Hf, were produced by bombarding a ^{144}Sm target with high-energy ^{19}F and ^{20}Ne ions. These nuclides decay primarily by alpha-particle emission. Alpha-decay energies and half lives were measured. An alpha-emitting isomeric state was observed for ^{166}Lu. The alpha reduced widths of these nuclides are close to those observed for other isotopes in this region. A search was made for proton-decay branches but none was observed. Some results of a ^{144}Sm + ^{32}S bombardment are presented, and speculations are made with regard to the future production of the ultra-neutron deficient 84- to 86-neutron isotopes above hafnium. (auth)

16983 BETA-DECAY ASYMMETRY AND NUCLEAR MAGNETIC MOMENT OF ARGON-35. Frank P. Calaprice (Univ. of California, Berkeley), Eugene D. Commins, and David A. Dobson. Phys. Rev., 137: B1453-5(Mar. 22, 1965). (UCRL-7999)

The asymmetry in beta emission from polarized ^{35}Ar nuclei and the nuclear magnetic moment of ^{35}Ar were determined by an atomic-beam method used previously for similar measurements on ^{19}Ne. The results are: for the asymmetry parameter, $A = +0.16 \pm 0.04$; and for the nuclear moment, $\mu = +0.632 \pm 0.002$ nm. The experimental value of A is used to obtain the Gamow-Teller beta-decay matrix element: $\langle\sigma\rangle = 0.10 \pm 0.05$. This result is consistent with the measured ft value and electron-neutrino angular correlation coefficient in the decay of ^{35}Ar. The results are also consistent with a rotational model of ^{35}Ar using a deformation parameter close to that of ^{35}Cl. (auth)

16984 THE NUMBER PROBLEM IN BARDEEN-COOPER-SCHRIEFFER AND RANDOM-PHASE-APPROXIMATION NUCLEAR CALCULATIONS. I. Unna (Brookhaven National Lab., Upton, N. Y.), and J. Weneser. Phys. Rev., 137: B1455-65(Mar. 22, 1965). (BNL-8445)

Use is made of the quasiboson method to study the problem arising from number nonconservation in applications of BCS methods to nuclear problems. This method neglects higher orders in $1/\Omega$, where Ω is an average number of available shell-model single-particle states. A method is given which identifies and removes number-dispersion spurious effects. The relation of this method to the prescriptions of Nogami and of Nilsson is discussed. An illustration of the method is given in an explicit calculation for the energy of a two-shell system in order Ω^2 and order Ω. It is shown that the projected BCS wave function method gives the leading order Ω^2 exactly and results in a good approximation to order Ω. Variation of the parameters of the projected wave function affords zero improvement in either order Ω^2 or Ω. (auth)

16985 STUDY OF THE EXCITED STATES OF B^{10} FROM 5 TO 8 Mev BY THE $B^{11}(He^3,\alpha)B^{10}$ REACTION AND A NOTE ON THE $B^{11}(He^3,t_0)C^{11}$ REACTION. S. Gorodetzky, A. Gallmann, and R. Rebmeister (Institut de Recherches Nucleaires, Strasbourg). Phys. Rev., 137: B1466-70(Mar. 22, 1965).

The reaction $^{11}B(^3He,\alpha)^{10}B$ at 60 and 90° at an incident energy $E = 4.9596 \pm 0.0030$ Mev and at 75° at $E = 4.7689 \pm 0.0030$ Mev. The energies of the ^{10}B states found by others were confirmed except for those found at 6.04 and 6.16 Mev for which the values 6.028 ± 0.005 and 6.131 ± 0.005 Mev, respectively, were obtained. The differential cross sections of this reaction were measured at the same three angles and are given up to the 7.56-Mev state. The $^{11}B(^3He,t_0)^{11}C$ reaction with a differential cross section of 0.32 ± 0.08 mb/sr at $\theta_{t_0} = 60°$, of 0.26 ± 0.07 mb/sr at 75°, and of 0.21 ± 0.05 mb/sr was also found. (auth)

16986 POLARIZATION OF PROTONS FROM THE $B^{10}(He^3,p)C^{12*}$ (4.43-Mev) REACTION. D. G. Simons (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park) and R. W. Detenbeck. Phys. Rev., 137: B1471-9(Mar. 22, 1965).

Proton polarizations were measured for the $^{10}B(^3He,p)^{12*}C$ (4.43-Mev) reaction at ^{3}He energies of 2.5 and 2.8 Mev. These measurements were made for twelve angles from 0 to 135° at 2.5 Mev and for six angles from 15 to 75° at 2.8 Mev. The measurements at 2.5 Mev show that the polarization reaches a minimum of -0.36 ± 0.07 at $\theta_{lab} = 15°$, where the sign of the polarization follows the Basel convention. At larger angles the polarization fluctuates and generally decreases. It could not be determined whether the polarization changes sign or is zero at the back angles. The angular dependences of the polarizations at 2.8 Mev are similar to those obtained at 2.5 Mev, indicating a weak energy dependence in the energy range used. The weak energy dependence is consistent with an interpretation of the reaction in terms of a direct reaction mechanism or a compound-nucleus process in which only a few, very broad levels are involved. The polarizations were analyzed by scattering the protons from a plastic scintillator, using the known properties of the polarization of protons scattered by carbon. With the plastic scintillator, it was possible to reduce the backgrounds in the side detectors. This was done by identifying the scattered protons as coincidences between the second scatterer and pulses of the proper energy in the side detectors. Geometrical uncertainties obtained by machine calculations are included in the statistical uncertainties. (auth)

16987 $N^{14}(He^3,n)F^{16}$ REACTION. C. D. Zafiratos (Los Alamos Scientific Lab., N. Mex.). F. Ajzenberg-Selove, and F. S. Dietrich. Phys. Rev., 137: B1479-84(Mar. 22, 1965). (LA-DC-6610)

Time-of-flight neutron spectra from the bombardment of a chromium nitride target by 3.5- and 6.2-Mev ^{3}He particles indicate five neutron groups corresponding to the ground state of ^{16}F and to excited states at 0.20 ± 0.05, 0.436 ± 0.030, 0.736 ± 0.040, and 3.78 ± 0.06 Mev, with widths of 50 ± 30, <40, 40 ± 30, <15 and <40 kev, respectively. The ground state Q value is -0.963 ± 0.040 Mev, corresponding to a ^{16}F atomic mass excess of 10.686 ± 0.040 Mev. The results are discussed in terms of the known information on the T = 1 states in the A = 16 isobaric triad. (auth)

16988 DETERMINATION OF SPINS OF NEUTRON RESONANCES AND THE HYPERFINE COUPLING CONSTANT IN Ho^{165}. G. Brunhart, H. Postma, and V. L. Sailor (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B1484-90(Mar. 22, 1965). (BNL-8570)

Neutron transmission measurements on targets of polarized holmium nuclei were extended using a holmium single crystal. Owing to the large hyperfine coupling in holmium and the complete magnetization of the single-crystal sample, it was possible to make spin determinations for the compound states corresponding to the neutron resonances at 18.2 and 21.3 ev. The spins were both found to be $I = 7/2 = 3$. The nuclear polarization of the sample was obtained as a function of temperature at 3.924-ev resonance, and the data were fitted to a theoretical curve with the magnetic and electric hyperfine splitting constants as fitting parameters. The results for the magnetic and electric hfs constants are, respectively, $A/k = 0.610 \pm 0.005$°K and $P/k = 0.002 \pm 0.001$°K. This corresponds to an effective magnetic field at the nucleus of 8.8×10^6 Oe. (auth)

16989 INTERACTIONS OF CADMIUM-106 WITH ALPHA PARTICLES. Richard L. Hahn (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B1491-9(Mar. 22, 1965). (BNL-8538)

The excitation functions of the (α,γ), (α,n), (α,p), $(\alpha,2n)$, (α,pn), $(\alpha,3n) + (\alpha,p2n)$, $(\alpha,\alpha n)$, and $(\alpha,2\alpha n)$ reactions of ^{106}Cd were determined with alpha particles of 6–39-Mev kinetic energy. Reactions involving charged-particle emission compete quite favorably with those involving neutron emission only; the large Coulomb barrier for charged-particle emission is partially offset by the relatively low separation energies for these charged particles, as compared to those for neutrons. Thus, some of the peak cross sections (and corresponding alpha-particle energies) are: (α,n), 626 mb (19 Mev); (α,p), 243 mb (22 Mev); $(\alpha,2n)$, 427 mb (32 Mev); (α,pn), 230 mb (35 Mev); and $(\alpha,\alpha n)$, 205 mb (37 Mev). Comparison of these data with the previously determined excitation functions for ^{124}Sn clearly demonstrates that the reactions leading to charged-par-

ticle emission in neutron-deficient ^{106}Cd are much more probable than are the analogous reactions on neutron-excess ^{124}Sn. The ratio of the sum of cross sections involving the emission of at least one charged particle to the sum of cross sections for the emission only of neutrons is more than an order of magnitude greater for ^{106}Cd than for ^{124}Sn. This behavior may be reproduced with the statistical theory of nuclear reactions, by using $r_0 = 1.7$ F for the radius parameter and $a = 1.8$/Mev for the level-density parameter. Detailed comparison of the data with compound nucleus theory shows good agreement for the (α,n), (α,p), and $(\alpha,\alpha n)$ excitation functions. A brief discussion of the principles of 4π scintillation counting is also presented. (auth)

16990 NUCLEAR SIZE AND MAGNETIC EFFECTS IN BREMSSTRAHLUNG FROM ELECTRON-NUCLEUS SCATTERING. Edward S. Ginsberg (Univ. of Pennsylvania, Philadelphia) and R. H. Pratt. Phys. Rev., 137: B1500-4 (Mar. 22, 1965).

The distribution in energy and angle of bremsstrahlung from the scattering of electrons by static nuclear charge and magnetic-moment distributions is calculated in Born approximation. As expected, large reductions from point-nucleus cross sections are obtained for bremsstrahlung involving large momentum transfers, and the effects of a magnetic-moment distribution are important for wide-angle bremsstrahlung. Integrations were carried out numerically by computer, using form factors determined by elastic electron scattering, for some representative cases. (auth)

16991 ANGULAR DISTRIBUTION AND POLARIZATION OF NEUTRONS FROM THE $Be^9(p,n_0)B^9$ AND $B^{11}(p,n_0)C^{11}$ REACTIONS. B. D. Walker, C. Wong, J. D. Anderson, and J. W. McClure (Univ. of California, Livermore). Phys. Rev., 137: B1504-8(Mar. 22, 1965). (UCRL-12019)

The angular distribution of neutrons from the ^{9}Be(p,n_0)^{9}B reaction was measured for the proton energies between 3.5 and 10.9 Mev and from ^{11}B(p,n_0)^{11}C reaction at 7.1 and 8.2 Mev over the angular range of 0 to 150°. The polarization of the neutrons from the two reactions was measured for proton energies from 7 to 11 Mev and neutron emission angles between 0 and 80°. Both experiments employed the time-of-flight facility. Neither the angular distribution nor the angular dependence of the polarization of the ^{9}Be(p,n_0)^{9}B neutrons changes appreciably with increasing proton energy, while for the ^{11}B(p,n_0)^{11}C reaction, both the angular distribution and polarization are quite energy-sensitive. These results are not in agreement with the twin-reaction hypothesis of Bloom et al. (auth)

16992 TOTAL CROSS SECTION FOR ^{9}Be(α,n). J. H. Gibbons and R. L. Macklin (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: B1508-9(Mar. 22, 1965). (ORNL-P-671)

The absolute total (4π) neutron yield from ^{9}Be(α,n) was measured for alpha energies from 1.7 to 10.5 Mev by extension of earlier measurements. In addition to previously reported states in ^{13}C, resonance peaks are observed corresponding to E_{ex} of 15.3 and 17.0 Mev. The widths for resonances at $E_\alpha = 1.92$, 2.25, and 2.58 Mev are 0.2, 0.4, and 0.3 Mev, respectively. Near $E_\alpha = 10$ Mev, reactions leading to states in ^{12}C apparently account for < 30% of the observed section. (auth)

16993 COULOMB SCATTERING IN ALUMINUM WITHOUT ATOMIC EXCITATION FOR 1-Mev ELECTRONS. David H. Rester and Walter J. Rainwater, Jr. (Ling-Temco-Vought, Inc., Dallas). Phys. Rev., 138: A12-14(Apr. 5, 1965).

The cross sections for Coulomb scattering of 1-Mev electrons without atomic excitation from thin aluminum targets were measured at scattering angles from 20 to 150 deg. The electron spectra were obtained by use of lithium-ion-drift silicon detectors. The experimental cross sections are compared with the theoretical values of Doggett and Spencer. Agreement is within the experimental error. (auth)

16994 PROPOSED DETECTION OF DYNAMICALLY ORIENTED Co^{57} BY THE MÖSSBAUER EFFECT. Sushil K. Misra and William A. Barker (St. Louis Univ.). Phys. Rev., 138: A58-62(Apr. 5, 1965).

The Mössbauer effect may be a useful probe of the static and dynamic mechanisms coupling a parent nucleus to a paramagnetic environment in a static or time-varying magnetic field. A theoretical expression is developed for the relative-intensity ratio R(v) for a transmission-type Mössbauer spectrum of the gamma radiation obtained in the decay of oriented ^{57}Co. This expression explicitly exhibits a sensitive dependence on the occupation numbers of the Zeeman levels of the parent nucleus. The ratio is calculated numerically for the cases of static and dynamic orientation in a field of 100 kG with the source held at 1°K and a warm absorber. Dynamic orientation is assumed to be achieved by the solid effect in which microwave pumping radiation induces transitions which flip the electron spin by one unit and the nuclear spin by two units. The value of R(v) for the dynamic case is mostly $\sim 10^{-7}$, but is $\sim 10^2$ when v is chosen to provide overlap of the $\frac{3}{2} \rightarrow \frac{1}{2}$ and $-\frac{1}{2} \rightarrow \frac{1}{2}$ emission lines with the $-\frac{1}{2} \rightarrow \frac{3}{2}$ and $-\frac{1}{2} \rightarrow \frac{1}{2}$ absorption lines, respectively. This differs significantly from R(v) for the static case, which is ~ 1 for the same two overlaps. (auth)

16995 POLARIZATION OF SILVER NUCLEI IN METALLIC IRON AND NICKEL. G. A. Westenbarger and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev., 138: A161-9(Apr. 5, 1965). (UCRL-11505)

Nuclei of ^{104}Ag and ^{110m}Ag were polarized at temperatures between 0.0105 and 0.97°K, employing the large hyperfine magnetic fields induced at the nuclei of silver atoms dissolved in iron and in nickel. The temperature and angular dependences of γ-ray angular distributions were used to determine the magnitudes of the hyperfine structure constants. Nonconservation of parity in beta decay was used to determine the signs of the internal fields, using germanium detectors to count positrons from ^{104}Ag and electrons from ^{110m}Ag. The hyperfine fields were found to be negative in both iron and nickel. Analysis of the γ-ray data on one-hour ^{104}Ag yielded approximate values for the internal fields: H_i(Ag in Fe) = -350 ± 100 kG, H_i(Ag in Ni) = -108 ± 30 kG. Cobalt-60 γ-ray thermometry was used, and the problems of thermometry at 0.01°K are discussed. Nuclear spins of four levels in ^{110}Cd were determined unambiguously, confirming earlier work, which was re-interpreted where necessary. The energy levels (spins) are 2162 kev (3+), 2219 kev (4+), 2479 kev (6+), 2926 kev (5+). The 1384-kev γ ray in ^{110}Cd was found to be (91.7 ± 2.8)% magnetic dipole and (8.3 ± 2.8)% electric quadrupole. The 1505-kev γ ray was (78.9 ± 4.8)% magnetic dipole and (21.1 ± 4.8)% electric quadrupole. An approximate value of +2.9 ± 1.3 nm was determined for the nuclear moment of ^{110m}Ag. (auth)

16996 ENERGY LEVELS OF He^4. P. D. Parker (Brookhaven National Lab., Upton, New York), P. F. Donovan, J. V. Kane, and J. F. Mollenauer. Phys. Rev. Letters, 14: 15-18(Jan. 4, 1965). (BNL-8622)

The particle-particle correlations in the three-body systems resulting from the bombardment of deuterium with a 31.8-Mev ^{3}He beam were studied. Two excited states were identified in ^{4}He at excitations of 19.94 ± 0.02 and 21.24 ± 0.2 Mev with widths of 140 ± 25 and 1.1 ± 0.2 Mev, respectively. The 19.94-Mev level was observed to decay by proton emission, while the 21.24-Mev level (apparently unreported previously) was observed to decay by both proton and neutron emission. (D.C.W.)

16997 HYPERNUCLEAR SPECTROSCOPY, UNITARY SYMMETRY, AND POSSIBLE ANALOG STATES. H. J. Lipkin (Argonne National Lab., Ill.). Phys. Rev. Letters, 14: 18-20(Jan. 4, 1965).

The hypernuclear states (SU(3) analog states) that would be formally classified in the same SU(3) multiplet as the ground states of stable nuclei are discussed. The properties of such states are considered, as well as meson (K^-) reactions in which these states might be produced. (D.C.W.)

16998 INFLUENCE OF A RANDOMLY ORIENTED MAGNETIC FIELD ON ANGULAR CORRELATIONS. E. Matthias, S. S. Rosenblum, and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 46-8 (Jan. 11, 1965).

The measurement of hyperfine fields by observation of the time dependence of perturbed angular correlations was studied. The effect of a randomly oriented magnetic field on angular correlations was calculated as a function of time, and a time-differential measurement of a random magnetic interaction was made with a source of ^{111}In dissolved in Ni. The magnetic field for Cd dissolved in Ni was determined to be 65.3 ± 1.6 kgauss. (D.C.W.)

16999 NEW REGION OF ALPHA RADIOACTIVITY. Ronald D. Macfarlane and Antti Siivola (McMaster Univ., Hamilton, Ont.). Phys. Rev. Letters, 14: 114-15(Jan. 25, 1965). (UCRL-11765)

An enriched ^{96}Ru target was bombarded with high-energy ^{16}O ions, and the alpha spectrum of the reaction products was measured. Two weak alpha groups were observed at 3.28 and 3.08 Mev, which decayed with half lives of 2.2 and 5.3 sec, respectively. The activities were attributed to ^{107}Te and ^{108}Te, respectively. (D.C.W.)

17000 EFFECT OF A Y_{40} DEFORMATION ON PROTON INELASTIC SCATTERING. R. C. Barrett (Columbia Univ., New York). Phys. Rev. Letters, 14: 115-17(Jan. 25, 1965).

A method is proposed for measuring the Y_{40} term in the shape of deformed heavy nuclei using measurements of the differential cross section for proton inelastic scattering. Calculations on the cross sections for inelastic scattering of 16- and 20-Mev protons on ^{238}U are considered as an example. (D.C.W.)

17001 HIGH-RESOLUTION MEASUREMENTS OF THE ISOTOPE SHIFT, FINE-STRUCTURE SPLITTING, AND ENERGY OF THE K ALPHA MUONIC X RAYS OF Mo^{96} AND Mo^{98}. C. Chasman, R. A. Ristinen, R. C. Cohen, S. Devons, and C. Nissim-Sabat (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 181-3(Feb. 8, 1965). (BNL-8715)

The Kα muonic x-ray spectra of ^{96}Mo and ^{98}Mo were studied, particularly the isotope shift in the $2p_{\frac{3}{2}} \rightarrow 1s_{\frac{1}{2}}$ transition. Energies of 2713.3 ± 1.1 and 2707.1 ± 1.1 kev were obtained for the transition in ^{96}Mo and ^{98}Mo, respectively, together with a fine structure splitting energy of 23.5 ± 0.9 kev. The isotope shift was found to be +6.2 ± 0.7 kev. (D.C.W.)

17002 PROMPT ELECTRON SPECTRA FROM Cf^{252} FISSION FRAGMENTS. R. L. Watson, H. R. Bowman, S. G. Thompson, and J. O. Rasmussen (Univ. of California, Berkley). Phys. Rev. Letters, 14: 183-5(Feb. 8, 1965).

The electron spectra originating from the internal conversion of prompt gamma rays from ^{252}Cf fission fragments of selected mass were measured in the energy range from 30 to 1000 kev. The electron spectra for the energy region between 300 and 600 kev were compared with gamma spectra previously obtained from ^{252}Cf fission fragments in this energy region. (D.C.W.)

17003 SEARCH FOR MASSIVE PARTICLES PRODUCED IN INTERACTIONS AT 30 Bev. P. Franzini, B. Leontic, D. Rahm, N. Samios, and M. Schwartz (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 196-7(Feb. 8, 1965). (BNL-8751)

The results are presented of an attempt to observe the production of moderately stable, negatively charged particles in the mass region from 2.5 to 5.0 Bev in proton reactions with tungsten nuclei. (D.C.W.)

17004 THE POLARIZATION OF RADIOACTIVE GOLD NUCLEI IN IRON. I. A. Campbell, N. J. Stone, and B. G. Turrell (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 283: 379-93(Jan. 19, 1965).

The γ radiation from the nuclei of ^{198}Au, ^{199}Au, and ^{195}Au polarized as diamagnetic impurities in ferromagnetic iron were studied down to 0.012°K, reached by thermal contact with an adiabatically demagnetized chrome potassium alum heat sink. Specimen temperatures were deduced from measurement of the anisotropic γ emission from ^{60}Co nuclei polarized in the same iron alloy. The importance of this technique in extending the temperature range and consequently the accuracy of interpretation of the measurements is discussed. From observation of the 412-kev γ ray in ^{198}Au and of the 158-kev γ ray in ^{199}Au, two independent and self-consistent values of $|H_{eff.}|$, the hyperfine coupling field present at gold nuclei in iron, were obtained. The mean value was $|H_{eff.}| = 1.35 \pm 0.05 \times 10^9$ Oe. With this value the ^{195}Au measurements yielded a nuclear magnetic dipole moment of ±(0.13 ± 0.04) nm for this isotope. The agreement of the value of $|H_{eff.}|$ found with that from Mössbauer studies of ^{197}Au in iron justified the assumed application of the ξ approximation to the first forbidden β transitions in the decays. Values for the ratio Δ of the linear combinations of matrix elements, V_0 and Y_1, corresponding to $j_\beta = 0$ and 1 respectively in the 959-kev β decay of ^{198}Au and the 250-kev β decay of ^{199}Au were found to be ±(0.82 ± 0.18) and ±$(1.86^{+0.8}_{-0.3})$ respectively. These results were compared with calculations based on the nuclear singleparticle model. (auth)

17005 ON THE "ANHARMONIC EFFECTS" ON THE COLLECTIVE OSCILLATION IN SPHERICAL EVEN NUCLEI. PART II. Toshio Marumori, Masatoshi Yamamura, Akira Tokunaga, and Kenjiro Takada (Kyoto Univ. and Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 32: 726-37 (Nov. 1964).

On the basis of a kind of perturbation theory starting with the solutions of the harmonic approximation (the random phase approximation) as the zeroth-order approximation, a method to evaluate the correction to the first 2^+ state and the splitting of the triplet (0^+, 2^+, 4^+) in the spherical even nuclei is presented. An essential difficulty that the states obtained under the harmonic approximation do not form an orthogonal set in rigorous sense is overcome by transcribing the original quasi-particle system into the ideal boson space according to the theory proposed previously. In this ideal boson space, the states obtained under the harmonic approximation form a complete orthogonal set, so that one can safely use them as the zeroth-order approximation. By adopting the hamiltonian with pairing plus quadrupole force, the results are compared with those obtained by Do Dang and Klein with their spectral decomposition method. It is shown that the results are very similar to theirs insofar as the phonon-quasi-particle coupling is neglected. The advantage of this method in evaluating the effects of phonon-quasi-particle coupling is emphasized. (auth)

17006 MESIC EFFECT IN THE BETA-DECAY IN A NUCLEUS. Reido Kobayashi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 750-6(Nov. 1964).

The mesic effect to the beta decay in a nucleus is investigated. The Villars' type contribution which is compared with the ordinary axial vector coupling is estimated by the perturbation method. The comparable value with the fourth component of the ordinary axial vector coupling is obtained. (auth)

17007 EXACT TREATMENT OF A CHARGE-INDEPENDENT PAIRING INTERACTION IN A DEGENERATE MODEL. Munetake Ichimura (Tokyo Univ. and Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 757-77(Nov. 1964).

A charge independent pairing interaction in j-j coupling scheme and a charge-spin independent pairing interaction in L-S coupling scheme are exactly solved in a degenerate model by the aid of group theory. Groups used are independent of the number of states concerned unlike the usual shell model technique. The method is deeply connected with the generalized Bogoliubov transformation and it is conjectured that this transformation combined with projection into the definite number and the isospin (symmetry) state is very useful for the treatment of pair-interacting many body system. The classification of states through the group used here are equivalent to the seniority scheme generalized for unlike particles and degenerate levels. This method simplifies mathematics somewhat and derives easily some

new properties of seniority scheme for unlike particles. (auth)

17008 THEORY OF TWO NUCLEON STRIPPING REACTIONS. I. (d,α) AND (α,d) REACTIONS. Ching Liang Lin and Shiro Yoshida (Tokyo Univ. of Education and Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 32: 885-903(Dec. 1964).

Two nucleon stripping reactions are formulated in a convenient form for the DWBA calculation based on the direct interaction mechanism. The cross section is written as a product of two factors– one is the spectroscopic factor which reflects the nature of the nuclear structure concerned, and the other is the one-body transition matrix element. The latter factor describes the process in which the target nucleus captures two nucleons as a cluster into an orbit which is characterized by a form factor. This method is applied to the interpretation of the experimental results by Harvey and comparisons are made with experiments of ^{40}Ca(d,α)^{38}K reaction. (auth)

17009 REDUCED WIDTHS AND STRENGTH FUNCTIONS. John P. Schiffer (Argonne National Lab., Ill.). Rev. Mod. Phys., 36: 1065-70(Oct. 1964).

A review is presented of several topics, namely: the inference of nuclear gross structure from fine structure; proton resonance studies; reduced widths; gross structure in fluctuations; and optical model calculations for ^{58}Ni + p. (T.F.H.)

17010 UNIFIED THEORY OF NUCLEAR REACTIONS. Herman Feshbach (Massachusetts Inst. of Tech., Cambridge). Rev. Mod. Phys., 36: 1076-8(Oct. 1964). (MIT-2098-62)

A thoeory of nuclear reactions is discussed, which is unified in that it includes both direct and compound-nucleus processes. The theory has not been applied in processes other than elastic and (in a limited way) inelastic scattering. The extension of the theory to include reactions other than simple scattering is discussed. (T.F.H.)

17011 AVERAGE COMPOUND-NUCLEUS CROSS SECTIONS. P. A. Moldauer (Argonne National Lab., Ill.). Rev. Mod. Phys., 36: 1079-84(Oct. 1964).

Calculations of energy averages of compound-nucleus cross sections are considered, within the framework of the Hauser-Feshbach (Phys. Rev. 87: 366(1952)) formula. The conditions for validity of the assumption of independence of formation and decay averages are investigated, as is the relation between average compound-nucleus formation and optical-model absorption. Examples are presented of the comparison of experimental and theoretical results for neutron elastic and inelastic scattering by various nuclei. (T.F.H.)

17012 THE CLUSTER MODEL, TIME DELAY, AND THREE-BODY BREAKUP. G. C. Phillips (Rice Univ., Houston, Tex.). Rev. Mod. Phys., 36: 1085-94(Oct. 1964). (TID-20753)

The cluster model and time delay aspects of nuclear reactions are discussed, and an attempt is made to show that the compound-nucleus–cluster-model view of reactions accounts for many observed phenomena and provides a guide for interpretation of nuclear data. The application of the model to nuclear reactions having three final-state particles is shown. (T.F.H.)

17013 STATISTICAL PROPERTIES OF COMPOUND STATES. C. E. Porter (Brookhaven National Lab., Upton, N. Y.). Rev. Mod. Phys., 36: 1094-1100(Oct. 1964). (BNL-8078)

A review is presented of energy-averaged cross sections, statistical properties of compound states, cross section probability distributions, and the application of the random-phase approximation to nuclear reactions. (T.F.H.)

17014 TIME DELAY MEASUREMENTS. R. M. Eisberg (Univ. of California, Santa Barbara). Rev. Mod. Phys., 36: 1100-2(Oct. 1964).

A discussion is presented of methods for measuring time delays and scattering amplitudes for nuclear reactions, within the framework of the compound-nucleus model. (T.F.H.)

17015 A FERMI SYSTEM GIVING THE EQUALLY-SPACED SPECTRUM. You-wen Yu, Tsung-yeh Chang, and Min Yu. Sci. Sinica (Peking), 13: 1919-41(Dec. 1964).

A system of N Fermi particles is proposed in which every particle has three degrees of freedom (angle θ, φ, and spin) and the degenerate configurations of each particle contain the orbital angular momentum from l_0, l_0-2, ... to 0 (for even l_0) or 1 (for odd l_0), totaling $2\sum_0^{l_0(\text{or }1)}(2l+1)=\Omega$. A δ-type interaction among the particles is assumed. The eigensolution of the model system is calculated and the properties of the solution and its physical picture are discussed. By comparing these properties with those of the atomic nucleus, the properties of the model system are qualitatively very similar to thos of the nuclei with equally spaced spectrum. (auth)

17016 APPLICATION OF THE FACTORIZATION POTENTIAL FOR ^{6}Li NUCLEUS. G. A. Chilashvili (State Univ., Tbilisi, USSR). Soobshch. Akad. Nauk Gruz, SSR, 34: 297-304(1964). (In Russian)

Previously obtained formulas were used to calculate the binding energy of the ^{6}Li ground state. The nucleus is considered as an α-n-p system. The three particles are assumed to interact with nonlocal factorization potentials: the Yamaguchi potential for the n-p interaction, the Mitra-Bhakar potential for the α-N interactions. Assumptions of charge symmetry and the same potential are made for the n-α and p-α interactions. The energy eigenvalues were obtained mathematically. A binding energy of 4.9 Mev was found, in reasonable agreement with the actual value of 3.71 Mev. (M.J.T.)

17017 SCATTERING OF NEUTRONS WITH ENERGIES OF 300, 500, AND 800 kev BY Mo, Sb, W, AND U NUCLEI. I. O. Korzh, M. T. Sklyar, and I. A. Tots'kii. Ukr. Fiz. Zh., 9: 929-32(1964). (In Russian)

The angular distributions for neutron elastic scattering at 300 and 500 kev by Mo, Sb, U, and W and at 800 kev by Mo, Sb, and W were measured. The total elastic cross section, the mean value of the cosine of the elastic scattering angle, the elastic transport cross section, and the transport cross section with allowance for inelastic scattering were calculated from the data. (D.C.W.)

17018 APPLICATION OF LANDAU'S THEORY OF FERMI LIQUIDS TO NUCLEAR MATTER. Hans-Juergen Krappe (Max-Planck-Institut fur Physik und Astrophysik, Munich). Z. Physik, 183: 146-58(1965).

Landau's theory of Fermi Liquids is applied to the hydrodynamic model of the giant resonance. It is shown that for reasonable range parameters of the effective force only the s- and p-wave contributions are important. The theory then can be characterized by four constants: the f-sum (including exchange corrections), the symmetry energy, the Fermi energy, and the effective mass. In heavy nuclei the Coulomb force has also to be taken into account. It leads to a shift of the position of the giant resonance by about 10 to 15%. (auth)

17019 (β,γ)-DIRECTIONAL CORRELATION IN THE DECAY OF Tm^{170}. PART I. MEASUREMENT OF THE DIFFERENTIAL DIRECTIONAL CORRELATION AND CALCULATION OF THE NUCLEAR MATRIX ELEMENTS. K. Runge (Universitat, Heidelberg). Z. Physik, 183: 184-94 (1965). (In German)

The beta-gamma directional correlation between the inner beta-group and the following 84.2-kev gamma ray was measured as a function of the energy of the beta particles. Details of the apparatus and the experimental procedure are given. The results are corrected for the contribution of internal bremsstrahlung and the attenuation of the directional correlation due to the relatively long lifetime of the excited state in ^{170}Yb and the presence of crystal fields. The directional correlation results were used with the results of measurements of the longitudinal polarization of the electrons and the shape of the beta spectrum given by others

to determine the nuclear matrix elements. The computer calculations showed that there are two physically different types of solutions. One is the so called modified $\int B_{ij}$ solution which is, however, unsatisfactory in the framework of the Bohr-Mottelson theory. By including higher order nuclear matrix elements we get a solution which is in agreement with this nuclear model. (auth)

17020 (β,γ)-DIRECTIONAL CORRELATION IN DECAY OF Tm^{170}. PART II. DETERMINATION OF THE REDUCTION OF DIRECTIONAL CORRELATION AND MEASUREMENT OF THE INTENSITY AND ANGULAR SCATTERING OF INNER BREMSSTRAHLUNG. D. Pfeifer and K. Runge (Universitat, Heidelberg). Z. Physik, 183: 195-206(1965). (In German)

Measurements of the beta-gamma directional correlation in the decay of ^{170}Tm were performed as a function of the time delay inserted in the fast coincidence circuit. Various chemical compounds of thulium were used to study the influences of the crystal fields and the chemical bonds on the directional correlation. Attenuations up to 40% were observed. The largest anisotropy was found with a liquid source of a Ga-Tm alloy. Also the intensity and directional correlation of the internal bremsstrahlung was measured. Since there is a pronounced angular dependence of the internal bremsstrahlung relative to the direction of the emitted beta particle, the directional correlation measurement can be disturbed seriously even if the intensity of the internal bremsstrahlung is weak. (auth)

17021 INVESTIGATION OF SLOWING DOWN OF SLOW ATOMS IN GASES BY THE γ-QUANTUM RESONANCE SCATTERING TECHNIQUE. A. F. Akkerman, V. L. Kochetkov, and V. N. Chekanov (Inst. of Nuclear Physics, Kazkh SSR). Zh. Eksperim. i Teor. Fiz., 48: 13-18 (Jan. 1965). (In Russian)

The cross section for resonance scattering of 325-kev quanta on ^{51}V nuclei is investigated as a function of density of the gaseous CrO_2Cl_2 source. The experimental dependence satisfactorily agrees with the theoretical prediction based on the elastic collision model. The diameter for collision between a ^{51}V atom and CrO_2Cl_2 molecule is 6.8 Å. Comparison of the results of the investigation with those of other resonance experiments indicates that at low recoil nucleus energies ($E_{kin} < 100$ ev) elastic collisions are the main slowing down factor. (auth)

17022 INTERNAL MAGNETIC FIELD IN W AND Ru ATOMS DISSOLVED IN IRON. V. D. Kulkov, A. V. Kogan, L. P. Nikitin, E. P. Savin, and M. F. Stelmakh (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 122-4(Jan. 1965). (In Russian)

The internal magnetic field H acting on nuclei of W and Ru isotopes dissolved in iron is measured. The value of H was determined from the anisotropy of γ rays from radioactive ^{187}W and ^{103}Ru nuclei oriented at very low temperatures. The value of H for W is approximately 1.1×10^6 Oe. The sign of asymmetry of γ rays from ^{103}Ru is determined and additional data on the decay scheme are obtained. (auth)

17023 SLOWING DOWN OF SLOW PROTONS IN METALS. B. A. Trubnikov and Yu. N. Yavlinskii. Zh. Eksperim. i Teor. Fiz., 48: 253-60(Jan. 1965). (In Russian)

Formulas describing the slowing down of slow protons in a degenerate plasma are derived. Two plasma models are considered: that of an ideal degenerate gas and that of a Fermi liquid. The results are in satisfactory agreement with the experimental data. (auth)

17024 SPONTANEOUS EMISSION OF γ-QUANTA FROM CRYSTALS. D. F. Zaretskii and V. V. Lomonosov (Inst. of Nuclear Energy, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 368-74(Jan. 1965). (In Russian)

Conditions for the appearance of a nuclear exciton in a crystal consisting of excited and unexcited nuclei of a given type are determined. The total probabilities for spontaneous γ-emission by a single excited nucleus or by an arbitrary number of excited nuclei in the crystal are derived. It is shown that the formation of a nuclear exciton is connected with an increase of the width of the emitting level and to the concentration of the radiation in a narrow solid angle. (auth)

17025 PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, 1964, CHANDIGARH, FEBRUARY 24–FEBRUARY 28, 1964. PART A, NUCLEAR PHYSICS. Bombay, Atomic Energy Establishment, 1964. 331p. (CONF-640202 (Pt. A))

Fifty-seven papers are included; separate abstracts have been prepared for 51. Six papers were previously abstracted for NSA; see abstracts 18:4525, 18902, 32822, 34843, 34871, and 38107. (M.J.T.)

For abstracts of individual papers see: 15926, 15927, 15928, 15929, 15930, 16322, 16413, 16651, 16652, 17026, 17027, 17028, 17029, 17030, 17031, 17032, 17033, 17034, 17035, 17036, 17037, 17038, 17039, 17040, 17041, 17042, 17043, 17044, 17045, 17046, 17047, 17048, 17049, 17050, 17051, 17052, 17053, 17054, 17055, 17056, 17057, 17058, 17059, 17060, 17061, 17062, 17063, 17064, 17065, 17066, and 17142.

17026 SELF-CONSISTENT-FIELD MODEL FOR LIGHT NUCLEI. Nazakat Ullah (Tata Inst. of Fundamental Research, Bombay). p.10-14 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The matrix version of the Hartree-Fock self-consistent-field method is applied to a system of nucleons, for the case when the internuclear potential has no worse than an integrable singularity (integrable hard core). An iterative computer program is used to carry out the self-consistent-field calculation. Calculated binding energies of ^{16}O, ^{15}O, and ^{14}N are compared with previous experimental values. (M.J.T.)

17027 STATISTICAL THEORY OF NUCLEAR ENERGY LEVELS. M. L. Mehta (Univ. of Delhi). p.21-3 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Correlations exist between the positions of the energy levels at high excitations in the neutron capture region of heavy nuclei, as is shown by a study of the two-level correlation function or the spacing distribution. Experimental values agree with a spacing distribution closer to the Wigner surmise of correlated levels than the Poisson curve obtained for a sequence of random levels. A mathematical model developed by Wigner and others, in which the nuclear hamiltonian is represented by a matrix of high dimension with random elements, is mentioned; studies using the model reproduce the experimental curves well. (M.J.T.)

17028 SYSTEMATICS OF NUCLEAR BINDING ENERGIES. S. C. Gupta, G. C. Aggarwal, and V. B. Bhanot (Panjab Univ., Chandigarh, India). p.24-6 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A formula developed by Thieberger and De-Shalit for nuclear binding energies, based on the two-body interaction and j-j coupling model, is presented. Recent data on binding energies are used to compute parameters in the formula; the formula can then be used to predict binding energies for nuclides where experimental data are not available. (M.J.T.)

17029 SHELL MODEL CALCULATIONS FOR THE ELASTIC SCATTERING OF ELECTRONS FROM p-SHELL NUCLEI. Pawan K. Bindal and Raj K. Gupta (Panjab Univ., Chandigarh, India). p.27-31 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The use of the modified oscillator distribution was extended to p-shell nuclei other than ^6Li. An expression for the nuclear form factor for p-shell nuclei is presented. Elastic scattering of electrons on ^9Be, ^{11}B, and ^{14}N at 160, 300, and 420 Mev, and on ^9Be at 190 Mev, was studied using this expression; calculated values of the cross section are compared with experimental results. (M.J.T.)

17030 SHELL-MODEL CALCULATION OF ENERGY SPECTRUM OF Na^{22}. S. N. Tewari (Saha Inst. of Nuclear Physics, Calcutta). p.32-5 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The SU(3) method developed by Elliott is used to classify intrinsic states of ^{22}Na. The states are labeled by a partition (f), describing symmetry under spatial permutations. Orbital states belonging to a given (f) are classified according to the irreducible representation of the SU(3) group labeled by two quantum numbers (γ,μ), which are defined in terms of the intrinsic quadrupole moment and the projection of the angular momentum. The wave functions used in the matrix-element evaluation are given. For ^{22}Na, SU(3) states within the ground partition are listed. The two-body Serber exchange potential is expanded in terms of ten operators. A calculation was done to estimate the admixture of higher (γ,μ). (M.J.T.)

17031 A STUDY OF THE REACTION $Ca^{40}(He^3,p)Sc^{42}$. N. Sarma (Atomic Energy Establishment, Trombay, India) and A. Sperduto. p.36-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A multiple gap spectrograph was used to study the reaction $^{40}Ca(^3He,p)^{42}Sc$ at 7 Mev. The Q-value was measured, and energy levels of ^{42}Sc were found. The spin and parity of the ground state were estimated. Results were fitted to the two-nucleon stripping theory of El Nadi and Sherif. Further measurements and calculations will be made. (M.J.T.)

17032 ANALYSIS OF (α,d) REACTION. B. K. Jain and N. Sarma (Atomic Energy Establishment, Trombay, India). p.40-4 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Amplitudes for light- and heavy-particle stripping in the (α,d) reaction are derived, using a notation and procedure developed by El Nadi and Sherif. The matrix element is expressed in terms of the light- and heavy-particle stripping amplitudes and the interference between the two processes, and the equation for the differential cross section is obtained. Selection rules for the processes are stated. The formula is applied to the determination of the cross section for the $^{10}B(\alpha,d)^{12}C$ reaction. (M.J.T.)

17033 NUCLEAR STRUCTURE STUDIES WITH DEUTERON-INDUCED REACTIONS. Paresh Mukherjee (Saha Inst. of Nuclear Physics, Calcutta). p.45-63 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Results of experiments and DWBA calculations on (d,p) and (d,t) reactions are reviewed. Applications of these reactions are surveyed: location of single particle states excited by these reactions on closed shell nuclei, determination of the ground state wave function, configuration mixing studies, and analysis of quasi-particle states. Present theoretical understanding of the $(d,^3He)$, (d,d'), and (d,α) reactions is also considered. (M.J.T.)

17034 DEUTERON STRIPPING AT LOW ENERGIES AND THE REACTION $Be^9(d,n)B^{10}$. D. K. Gupta (Banaras Hindu Univ., India). p.70-1 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Angular distributions of four groups of neutrons corresponding to ^{10}B levels from 4.77 to 5.58 Mev were studied for deuteron energies from 2 to 3 Mev and compared with Butler's theory. Spin-parity assignments to the ^{10}B levels were made. (M.J.T.)

17035 ON THE POLARISATION AND ANGULAR DISTRIBUTION OF D-D NEUTRONS. P. P. Kane (Indian Inst. of Tech., Bombay). p.72-7 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Measurements of the neutron polarization and angular distribution from the reaction $D(d,n)^3He$ were made previously to 2 Mev. Disagreements among the various measurements are discussed, using an equation of Fierz for the product of the polarization and the differential cross section and a relation for the polarization from the theory of Beiduk et al. (M.J.T.)

17036 RECENT DEVELOPMENTS IN THE THEORY OF NUCLEAR REACTIONS. Manoj K. Banerjee (Saha Inst. of Nuclear Physics, Calcutta). p.78-90 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Developments in the unification of the direct reaction and compound nucleus theories are reviewed, with discussions of the projection operator, neutron elastic scattering, and approximations for energies and widths of the resonances in the scattering amplitude. The Drozdov-Blair model for inelastic scattering of alpha particles by deformed nuclei is discussed. Stripping and pick-up reactions on highly absorptive nuclei are considered, using the (d,p) process as an example. The dispersion theoretic model of direct reactions is discussed, using elastic unitarity. (M.J.T.)

17037 INELASTIC NEUTRON SCATTERING CROSS SECTION IN Au^{197}. N. C. Singhal and P. N. Trehan (Panjab Univ., Chandigarh, India). p.91-4 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Theoretical calculations of the inelastic neutron scattering cross section for excitation of the 268, 278, 474, and 510 kev levels in ^{197}Au were made using the method of Hauser and Feshbach, for neutron energies from 400 to 700 kev. Probable spin-parity assignments for the levels are decided by comparison of the calculated cross sections with the experimental values of Lind and Day. (M.J.T.)

17038 STUDIES OF (n,α) REACTIONS USING COUNTERS. C. Badrinathan, U. T. Raheja, and E. Kondaiah (Tata Inst. of Fundamental Research, Bombay). p.100-5 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The $^{19}F(n,\alpha)^{16}N$ reaction at 4.7 Mev was studied, using a gas proportional counter and coincidence methods; the angular distribution for 0 to 60° is given. The $^{19}F(n,\alpha)^{16}N$ and $^{27}Al(n,\alpha)^{24}Na$ reactions were studied at 14.1 Mev, using a Si surface barrier detector, and the alpha asymmetry ratios were obtained. (M.J.T.)

17039 ANALYSIS OF THE ANGULAR DISTRIBUTION FOR THE $C^{12}(n,\alpha)Be^9$ REACTION. M. L. Chatterjee and B. Sen (Saha Inst. of Nuclear Physics, Calcutta). p.106-11 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The reaction $^{12}C(n,\alpha)^9Be$ was studied at 14.5 Mev, using nuclear emulsions. The alpha energy spectrum and angular distributions are given, and attempts are made to fit the data with $|j_l(qR)|^2$ and Born-approximation formulas, for the knock-on, pick-up, and heavy-particle stripping mechanisms. Results are compared with those at previous experiments. (M.J.T.)

17040 SHELL EFFECTS IN 14 Mev (n,p) AND (n,α) REACTIONS. A. Chatterjee (Saha Inst. of Nuclear Physics, Calcutta). p.112-15 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Shell effects in (n,α) and (n,p) data were analyzed by observing the variations of the residual nuclear charge with the cross section around 14 Mev. The shell effects are considered in the statistical model, using the Weisskopf-Ewing formula and the free gas model of two fermions. An expression is obtained for the shell-dependent level density; values for parameters in this expression were computed for residual nuclei to Z = 52 for (n,α) reactions. (M.J.T.)

17041 ANISOTROPY AND ASYMMETRY IN THE FISSION OF U-235 INDUCED BY 4-Mev NEUTRONS. S. S. Kapoor, D. M. Nadkarni, R. Ramanna, P. N. Rama Rao, S. R. S. Murthy, and B. R. Ballal (Atomic Energy Establishment, Trombay, India). p.120-5 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The relation between angular anisotropy and mass asymmetry was studied in the 4-Mev neutron fission of ^{235}U. Mass distributions and kinetic energies of pair fragments emitted at 0 and 90° to the incident beam were determined, using solid-state detectors. Results are presented, and possible mechanisms of the fission process are discussed. (M.J.T.)

17042 SPIN AND PARITY OF THE 1.42-Mev LEVEL OF A^{37}. K. V. K. Iyengar, S. K. Gupta, and E. Kondaiah (Tata Inst. of Fundamental Research, Bombay). p.126-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The $^{37}Cl(p,n)^{37}Ar$ reaction at 5.5 Mev was studied, using plastic scintillators and time-of-flight techniques. Neutron spectra and gamma-neutron angular correlations are presented for 0, 30, and 60°. The angular correlations are in agreement with calculations assuming an assignment of $\frac{1}{2}^+$ to the ^{37}Ar 1.42-Mev state. (M.J.T.)

17043 GAMMA RAYS FROM INELASTIC SCATTERING OF PROTONS. P. N. Trehan (Panjab Univ., Chandigarh, India). p.130-42 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Experiments using the $(p,p'\gamma)$ reaction for the study of the level structure of medium weight even-even nuclei are reviewed. The target chamber set-up is described. Studies on decay schemes of even-even nuclei—^{70}Ge, ^{60}Ni, ^{62}Ni, ^{64}Zn, and ^{66}Zn—are reported. Work on angular distributions and excitation cross sections of $(p,p'\gamma)$ on Zn, Ge, and Ni isotopes is discussed; comparisons of results with statistical theory predictions, in order to assign spin-parity, are considered. Use of p inelastic scattering to measure the E2/M1 mixing ratio for the $2'^+ \rightarrow 2^+$ transition is surveyed. (M.J.T.)

17044 THE $O^{16}(\alpha,\alpha'\gamma$ 6.14 Mev)O^{16} REACTION. M. K. Mehta (Atomic Energy Establishment, Trombay, India), W. E. Hunt, and R. H. Davis. p.143-6 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The $^{16}O(\alpha,\alpha'\gamma)^{16}O$ reaction was studied for alpha energies from 9.5 to 19 Mev. Curves for excitation to the states at 6.14, 6.92, and 7.12 Mev are presented. Attempts to fit the 6.14-Mev gamma-ray angular distributions to theoretical curves are illustrated. (M.J.T.)

17045 ANGULAR DISTRIBUTION OF 2.21-Mev GAMMA RAYS FROM ALUMINIUM. Joseph John, M. R. Dwarakanath, A. S. Divatia, and S. S. Kerekatte (Atomic Energy Establishment, Trombay, India). p.148-51 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Inelastic scattering of 4.6- to 5.0-Mev protons by ^{27}Al, in which the Al nucleus is left in the 2.21-Mev excited state, was studied. The proton excitation function, 2.21-Mev gamma yield, and 2.21-Mev gamma angular distributions at three resonances are presented. The resonances are discussed in terms of statistical theory and Legendre polynomial expansions of the gamma angular distributions. (M.J.T.)

17046 ROTATIONAL STATES IN DEFORMED EVEN-EVEN NUCLEI. P. C. Sood (Panjab Univ., Chandigarh, India). p.182-91 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The basic ideas in the Bohr-Mottelson hydrodynamical collective model are presented. Spectra for axially symmetric even-even nuclei in the strong coupling limit of the BM model are discussed. Deviations from the I(I + 1) law in rotational spectra, arising mainly from the rotation-vibration interaction, are considered. Attempts to explain negative parity bands using the theory of axially symmetric nuclei are mentioned. The expression for the rotational energy in the ground state band is examined. It is found that the inclusion of second-order corrections is necessary to predict energies of the high-spin states and also affects significantly the values of the rotation-vibration coupling parameter. It is found that a major part of the corrections arises from the rotation-vibration interaction. An analytic expression for the energy, giving the rotational spectrum in one limit and the vibrational in the other, is obtained. Predictions of the rotation-vibration model of Faessler and Greiner are compared with experimental results and results of the nonaxial rotor model for ^{188}Os. The effects of band mixing are mentioned. It is seen that the axially symmetric model of Bohr and Mottelson, with corrections for vibration-rotation interaction and inclusion of band-mixing effects, satisfactorily explains energy levels and other properties in deformed nuclei. (M.J.T.)

17047 CRITERIA FOR THE APPLICABILITY OF NUCLEAR MODELS. S. Mahajan, Raj K. Gupta, and P. C. Sood (Panjab Univ., Chandigarh, India). p.192-8 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Systematics of three nuclear properties—level spacings, deformation parameter, and enhancement factor—are examined, as functions of atomic number, neutron number, and proton number, to determine the boundaries of the regions where the spherical and deformed nuclear models are applicable. It is concluded that the E2 enhancement factor over the single particle model estimate (rather than the deformation parameter) and the level spacings or energy ratios serve as better criteria in demarcating the spherical and the nonspherical regions. There is an abrupt change in nuclear properties between N = 88 and 90; nuclei with N = 90 are deformed but not rotational: the transition to the pure rotation pattern is gradual and smooth. It is also found that around A ~ 190 and A ~ 224, the proton number defines separation boundaries better than the neutron number. (M.J.T.)

17048 DEVIATIONS FROM I(I + 1) LAW IN RARE EARTH EVEN-EVEN NUCLEI. B. L. Gambhir, Raj K. Gupta, and P. C. Sood (Panjab Univ., Chandigarh, India). p.199-205 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Expressions for the energy spectrum of nuclei in the axially symmetric rotor model of Bohr and Mottelson are given, for pure rotations and for first- and second-order corrections due to rotation-vibration perturbations. Constants in these three different expressions are derived and compared for even-even rare earth nuclei. (M.J.T.)

17049 VIBRATIONAL STATES IN EVEN-EVEN SPHEROIDAL NUCLEI. Raj K. Gupta and P. C. Sood (Panjab Univ., Chandigarh, India). p.206-12 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Expressions are given for corrections to the pure rotational spectrum in the Bohr-Mottelson hydrodynamical model due to coupling of the one-phonon β-(first excited 0^+ level) and γ-(second excited 2^+ level) vibrational states. Separate coupling parameters for the β and the γ bands are defined, based on experimental indications. Levels in the excited bands were compared using the empirical moment of inertia and the coupling parameters derived from the band head energy. These comparisons were performed for all cases with known excited bands. The results obtained for ^{166}Er and ^{182}W are given and discussed. (M.J.T.)

17050 CORRECTIONS TO ROTATIONAL SPECTRA IN EVEN-EVEN NUCLEI IN THE ACTINIDE REGION. S. D. Sharma, Raj K. Gupta, and P. C. Sood (Panjab Univ., Chandigarh, India). p.213-18 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

First- and second-order corrections to the rotational spectra, due to the rotation-vibration interaction, are obtained for several actinide nuclei, using the Bohr-Mottelson hydrodynamical model. Comparisons of calculated parameters and experimental results are made. (M.J.T.)

17051 REMARKS ON M4 TRANSITIONS AND NUCLEAR CORE ISOMERISM. S. M. Brahmavar and M. K. Rama-

swamy (Karnatak Univ., Dharwar, India). p.219-25 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

M4 transitions of the types $g_{9/2} \rightarrow p_{1/2}$, $h_{11/2} \rightarrow d_{3/2}$, and $i_{13/2} \rightarrow f_{5/2}$ and the relative probabilities of odd-proton and odd-neutron transitions are considered in the independent particle model. Data on relevant M4 transitions are presented; it is found that for the first type of transition the odd-proton and odd-neutron matrix elements are essentially the same, except for ^{89}Y, and for the second type the odd-proton value is larger. Core isomerism in ^{93m}Mo and ^{211m}Po is discussed, and cases of core isomers consisting of a core with a neutron closed shell plus an odd neutron are listed and considered, to obtain some kind of systematics. (M.J.T.)

17052 ON THE SINGLE-PARTICLE STATES OF ODD-NEUTRON LANTHANIDE NUCLEI. B. N. Subba Rao (Tata Inst. of Fundamental Research, Bombay). p.228-31 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The single quasiparticle states of the superfluid model are characterized by the same set of quantum numbers as for the corresponding single particle states of the spheroidal shell model, and effects of pairing correlations are taken into account in evaluating nuclear properties. Spins, parities, and asymptotic quantum numbers for ground states of odd-neutron nuclei are presented and compared with predictions of the spheroidal shell model. Ground and excited states of several nuclei are assigned an empirical deformation parameter; the required sequence of single particle states was not obtainable. Thus significant effects on nuclear properties are present even after pairing correlations of nucleons are considered, indicating the existence of residual interactions not yet incorporated in the superfluid model. (M.J.T.)

17053 ON THE LEVELS OF I^{129} AND I^{131}. S. H. Devare and H. G. Devare (Tata Inst. of Fundamental Research, Bombay). p.243-7 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Results are reported of measurements on the lifetime and the conversion coefficient of the gamma rays from the first excited states of ^{129}I and ^{131}I. Measurements were made by the beta-gamma coincidence technique. Values of half lives are compared with those obtained from the single-particle estimates for M1 transitions. (M.J.T.)

17054 LEVELS IN Pm^{151}. K. P. Gopinathan and M. C. Joshi (Tata Inst. of Fundamental Research, Bombay). p.248-53 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The intensities of the gamma spectrum, γ-γ coincidences, the beta spectrum, and β-γ coincidences in the $^{151}Nd \rightarrow {}^{151}Pm$ decay were measured using a NaI(Tl) gamma spectrometer and an anthracene beta spectrometer. The energy level scheme of ^{151}Pm is presented, and levels are discussed with relation to other measurements and to possible structure of the nuclear levels. (M.J.T.)

17055 DECAY OF Pt^{197m}. K. P. Gopinathan (Atomic Energy Establishment, Trombay, India), K. G. Prasad, and M. C. Joshi. p.254-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The decay of ^{197m}Pt, produced by reactor-neutron irradiation of ^{196}Pt, was studied using NaI(Tl) detectors and spectrometers. The gamma spectrum and coincidence gamma spectrum were measured, and the decay scheme for ^{197}Pt and ^{197m}Pt going to ^{197}Au and ^{197m}Au is presented. (M.J.T.)

17056 RADIOACTIVE DECAY OF Sr^{93}. S. K. Mukherjee and H. Bakhru (Saha Inst. of Nuclear Physics, Calcutta). p.266-70 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The half life and beta and gamma energy spectra of ^{93}Sr were measured, using a G-M counter, NaI(Tl) gamma spectrometer, and anthracene beta spectrometer. Measurement results and the $^{93}Sr \rightarrow {}^{93}Y$ decay scheme are presented. (M.J.T.)

17057 THE 2.73-Mev LEVEL OF Mo^{96}. B. B. Burman Roy, S. Shastry, and R. L. Bhattacharyya (Saha Inst. of Nuclear Physics, Calcutta). p.271-3 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Measurements of internal conversion and γ-γ angular correlations in the $^{96}Tc \rightarrow {}^{96}Mo$ decay were made to determine multipolarity and spin-parity of the ^{96}Mo 2.73-Mev level. Gamma-ray energies and internal conversion coefficients for four transitions are presented and compared with theoretical results. The decay scheme, giving spin-parity assignments, multipolarities, and log ft and branching-ratio values, is presented. (M.J.T.)

17058 BETA-GAMMA ANGULAR CORRELATIONS. R. M. Singru (Tata Inst. of Fundamental Research, Bombay). p.274-80 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Expressions are given for the angular correlation between a β particle and an immediately following γ ray, the angular correlation in a β-γ directional correlation experiment, and the degree of circular polarization in a β-γ circularly polarized correlation experiment. Calculations of allowed and first forbidden β transitions and approximations involved are discussed. (M.J.T.)

17059 LEVELS IN La^{140} POPULATED IN THE β DECAY OF Ba^{140}. Y. K. Agarwal, C. V. K. Baba, and S. K. Bhattacharjee (Tata Inst. of Fundamental Research, Bombay). p.281-4 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Spins of excited states and multipolarities of transitions involved in the $^{140}Ba \rightarrow {}^{140}La$ beta decay were studied, using β-γ and γ-γ directional correlation techniques. The decay scheme, showing log ft values, branching ratios, spin-parity, and multipolarities, is given. (M.J.T.)

17060 SPIN OF THE 3.22-Mev LEVEL OF Sr^{88}. S. Shastry and R. Bhattacharyya (Saha Inst. of Nuclear Physics, Calcutta). p.289-91 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

A NaI(Tl) phosphor and multichannel analyzer were used to study the gamma rays in the $^{88}Y \rightarrow {}^{88}Sr$ decay. The highest excited state of ^{88}Sr was determined to be 3.52 Mev. The cascade relation of the 1.36- and 1.86-Mev gammas was established. A γ-γ angular correlation study was used to determine the spin-parity of the 3.22-Mev level. The energy level scheme is presented. (M.J.T.)

17061 ANGULAR CORRELATION AND LIFE-TIME MEASUREMENTS IN THE DECAY OF Cd^{115m}. R. P. Sharma, V. R. Pandharipande, and Girish Chandra (Tata Inst. of Fundamental Research, Bombay). p.292-6 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Positive parity levels of ^{115}In at 930, 1125, 1280, and 1420 kev were studied, using γ-γ and β-γ angular correlation data and directional correlation functions. An energy level diagram with the determined spin assignments is given, for the $^{115m}Cd \rightarrow {}^{115}In$ decay. (M.J.T.)

17062 HALF LIFE MEASUREMENT OF NUCLEAR LEVELS BY DELAYED COINCIDENCE TECHNIQUE. I. M. Govil and C. S. Khurana (Muslim Univ., Aligarh, India). p.298-9 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The delayed coincidence method was used to measure transition probabilities, and thus the half lives, of the first excited states in ^{131}Cs, ^{133}Cs, ^{141}Pr, and ^{143}Pr. The half-life values are presented and compared with single particle shell model calculations, giving the M1 retardation factor and the E2 enhancement factor. (M.J.T.)

17063 INCOHERENT SCATTERING OF 280-kev GAMMA RAYS. B. S. Sood, M. Singh, and S. Anand (Panjab Univ., Chandigarh, India). p.300-3 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Gamma rays from a ^{203}Hg source were scattered from Al, Cu, and Fe ring scatterers at 4 to 10°, to investigate effects of the binding of the electrons to the atom and their motions and distributions within the atom. Total cross sections were measured and subtracted from coherent cross sections calculated from data on atomic form factors to obtain the incoherent cross sections. The resulting incoherent cross sections are presented and compared with those from Klein-Nishina calculations, calculations for an atom with a Thomas-Fermi electron distribution, and calculations by Lenz. (M.J.T.)

17064 INVESTIGATION OF POLARIZATION OF ELASTICALLY SCATTERED GAMMA RAYS. M. Singh and B. S. Sood (Panjab Univ., Chandigarh, India). p.304-7 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Measurement of polarization of gamma rays to about 1 Mev provides a test of the theories of Rayleigh scattering which predict very different polarizations at different angles and energies. Discrepancies between previous data and predictions were investigated by varying the contributions of inelastic and elastic scattering to the observed scattered spectrum using filters in front of the detector and measuring polarizations in the different regions of the spectrum containing known amounts of elastic and inelastic scatterings. Spectra of 662 kev gammas scattered at 64° from Pb and from Al having the same number of electrons as the Pb are shown. Polarization measurements on 662 kev and 1.25 Mev gammas scattered on Pb at 64° are also given. Results show that the experimental value of percentage polarization depends on the contribution of inelastic scattering; when the inelastic and elastic scattering are separated, the experimental values agree fairly well with theoretical ones. (M.J.T.)

17065 "Z" DEPENDENCE OF THE COHERENT SCATTERING OF GAMMA RAYS. S. Anand and B. S. Sood (Panjab Univ., Chandigarh, India). p.308-11 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Previous calculations of Rayleigh-scattering Z and energy dependence and some experiments are reviewed. Elastic scattering of 662- and 280-kev gamma rays at 50 to 150° from different elements with Z from 42 to 82 was measured and results are reported. The contribution of nuclear Thomson scattering was subtracted from the total measured cross section to obtain Rayleigh scattering cross sections. The variation of the differential cross section with the atomic number and the momentum transfer is presented and compared with theoretical predictions. (M.J.T.)

17066 PHOTON ELASTIC SCATTERING CROSS SECTIONS AT 1.12 AND 0.662 Mev. V. A. Narasimhamurty, J. Ramarao, V. Lakshminarayana, and Swami Jnanananda (Andhra Univ., Waltair, India). p.312-16 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

Total elastic scattering cross sections of ^{46}Sc gamma rays (1.12 Mev) on Pb, Pt, Ta, and Sn were measured, in a search for possible Delbruck scattering. Studies on the angular and Z dependence of the Rayleigh-scattering cross section were also performed at 662 kev, using a ^{137}Cs source. The Standing-Jovanovich mathematical method and the conventional aluminum difference method were used to correct for the inelastic contribution. Results are presented and compared with theoretical values of Brown et al and with Bethe's form-factor values, for five angles between 20 and 90°. (M.J.T.)

17067 ZEEMAN EFFECT STUDIES ON N.Q.R. LINES. V. Nagarajan and C. R. K. Murty (Andhra Univ., Waltair, India). p.402-4 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

The principles of Zeeman-effect studies on NQR lines are reviewed. An r-f spectrometer was developed in which the magnetic field cannot only be tilted about the horizontal, but after the tilt is obtained the coils can be rotated about the axis perpendicular to the field plane. The system was used to study the splittings in the principal plane of the field gradients for a crystal of 2,5-dichloronitrobenzene; the measured asymmetry parameters are given and compared with those obtained using a conventional coil system. (M.J.T.)

17068 ELASTIC SCATTERING OF PROTONS BY ^4He. P. W. Allison and Rodman Smythe. 5p. (CONF-640606-16)

From American Physical Society Summer Meeting, Denver.

The differential cross section for proton elastic scattering by ^4He was measured at four laboratory energies from 20.6 to 27.6 Mev. The results are tabulated for angles from 5 to 174°. (D.C.W.)

17069 LECTURES ON FEW NUCLEON SYSTEMS. G. C. Phillips (Rice Univ., Houston, Tex.). 109p. (CONF-13-14)

From American Physical Society 1963 Southwestern Meeting, Houston, Tex., Feb. 1963.

A review is given of information on 3-, 4-, and 5-nucleon systems, obtained from experiments on nucleon-nucleon interactions. Static theoretical methods of treating few-nucleon systems, including the shell, cluster, and Rayleigh-Ritz variational models, are surveyed, and examples of calculations are given. Theoretical methods for few-nucleon systems using elastic and inelastic scattering are discussed, including variational methods with the cluster model and the Born approximation. Few-nucleon dynamics are considered, using the example of three-particle breakup. Recent experimental results are reported on $D(p,2p)n$, $H(d,2p)n$, $D(p,np)H$, $^3He(^3He,2p)^4He$, $^3He(^3He,\alpha p)H$, and $^{11}B(p,2\alpha)^4He$ reactions. 68 references. (M.J.T.)

Plasma Physics and Thermonuclear Processes

Refer also to abstract 16248.

17070 (AD-603685) DETERMINATION OF THE TEMPERATURE PROFILE OF AN OPTICALLY THICK CYLINDRICALLY SYMMETRIC LABORATORY PLASMA (thesis). Paul W. Elder (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). May 1964. 52p. (GSP/Phys/64-3). $3.00(CFSTI).

The temperature profile of a self-absorbing radially symmetric cylindrical laboratory plasma was experimentally determined using a spectroradiometric technique. The technique involves the measurement of the ratio of the spectral radiant emittance of the plasma gas to its spectral absorptivity which, according to Kirchhoff's law, is equal to the spectral radiant emittance of a black body at the same temperature and wavelength. The method does not depend on knowledge of the transition probabilities or number densities of the gas under study, or even its composition, and it is valid whenever departures from local thermal equilibrium in the plasma are small. (auth)

17071 (AFCRL-63-377) PLASMA ELECTRON TEMPERATURE IN A STRONG INHOMOGENEOUS ELECTRIC FIELD. Scientific Report No. 4. Harry M. Cronson and Lewis Wetzel (Brown Univ., Providence, R. I. Div. of Engineering). June 1963. Contract AF19(628)-2498. 101p. (AD-422962). $9.10(CFSTI).

Electron temperature effects occurring when the electrons of a plasma become heated by a strong inhomogeneous electric field are studied. Steady-state transport equations, based on kinetic theory, which admit elevated, spatially varying, electron temperatures; density gradients; and induced electric fields are constructed for both a weakly ionized and strongly ionized gas in a strong electric field. The physical meaning of these equations is discussed. They are then applied to determine the effect of a prescribed, strong standing wave on an initially

homogeneous plasma. Here two modes of behavior are distinguishable. In the low frequency case the electron temperature "follows" the field and the electron temperature and electron and ion density show strong spatial dependence. The induced field linking the electrons and ions is relatively strong. In the second high frequency mode the electron temperature establishes itself around some mean value with small spatial perturbations. For this case density gradients and the induced field are negligible. (auth)

17072 (ARL-64-220) A SURVEY OF CESIUM PLASMA RESEARCH. John A. Decker, Jr. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1964. 42p. CFSTI.

A critical survey of research on the plasma physics of cesium is presented. Primary emphasis is placed on the utilization of the unique characteristics of cesium in plasma generation and measurement, including the results of current basic research. In addition reference is made to work of historical interest and to several current applications of cesium plasma technology. (auth)

17073 (IPP-6) COMMENTS ON ESCAPE OF PARTICLES FROM MAGNETIC BOTTLES WITH NON-ADIABATIC PERTURBATION OF FIELD. Ladislav Krlin (Československá Akademie Věd, Prague (Czechoslovakia) Ústav Fyziky Plazmatu). Mar. 1963. 61p. Dep.(mn).

The solution of the state of particles in a bottle which is marked by a mirror effect produced by an adiabatic growth of the field and by a non-adiabatic perturbation of the main field is investigated. A concrete application consists in a calculation of the escape of particles which were either injected into or contained in the bottle. On the basis of the concept of recurrence theorem and of the properties of canonical transformations a set of equations for the determination of the certain type of the distribution function of the system is derived. A method of solution of the set of equations is produced and the calculation of the escape of particles is carried out with the use of special approximations. Certain more general questions of injection into a magnetic field are also considered. The work is not claimed to be complete, even under limiting assumptions. Thus, for instance, no possibility was found in literature of a comparison with the results of an analogous concept. Nevertheless it is assumed that the method suggested could be the object of a more detailed investigation. (auth)

17074 (IPP-9) STATIONARY CONFIGURATION OF PLASMA IN MAGNETIC BOTTLE WITH MIRRORS. Karel Jungwirth (Československá Akademie Věd, Prague (Czechoslovakia) Ustav Fyziky Plazmatu). Mar. 1963. 59p. Dep. (mn).

The relations are found, by the method of moments of the Boltzmann-Vlasov equation, between the macroscopic quantities of high temperature plasma (i.e., the number density of particles, the mass velocity, and generally the anisotropic tensor of the kinetic pressure of particles) on one hand and the magnetostatic field of an adiabatic mirror bottle by which the plasma is confined on the other. It is assumed that the kinetic pressure of the particles is much lower then the pressure of the magnetic field. The solution is found in the form of a power series of a small parameter which is the ratio of the Larmor radius to the characteristic dimension of the bottle. The zero approximation is identical with the CGL approximation. The case of infinitely long cylinder of plasma confined by an external homogeneous magnetic field is solved exactly, similarly as it is done in the case of plasma with plane geometry. (auth)

17075 (PAN-558/IX-A) ORTIMALIZANIYA PARAMETROV PLAZMENNOI USTANOVKI S KOAKSIALY'YM INZHEKTOROM. (Plasma Assembly With Coaxial Plasma Gun). S. Khvashchevski (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). Oct. 1964. 14p.

To obtain fast and short plasmoids in a coaxial plasma gun the gas volume introduced into the gun and the time delay of the discharge start were varied. The maximum density of the detected plasmoids occurred at velocity 1.3×10^7 cm/sec. In this condition the electron temperature measured with double probe was 20.8 ev and the ion density 1.5×10^{11} ions/cm^3. The pulse characteristics of the plasma radiation was investigated by means of a phototelescope. (auth)

17076 (SU-SEL-64-091) SHEET-PINCH STABILITY. Technical Report No. 0256-3. Donald R. Dobrott (Stanford Univ., Calif. Stanford Electronics Labs.). Aug. 1964. Contract AT(04-3)-326. 157p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The stability of a sheet pinch of the Bennett type is tested against quasi-electrostatic perturbations in the vicinity of the self-field neutral point. The sheet is stabilized by a strong, uniform magnetic field, set parallel to the uniform, macroscopic drift. The analysis is made within the kinetic theory framework of the Vlasov equation for ions and electrons. Approximate particle orbits are derived from nonlinear equations of motion by perturbation methods due to Krylov and Bogoliubov. The ratio of particle pressure to magnetic pressure, $\beta \ll 1$, is used as an expansion parameter. Drifts due to the shear in the magnetic field appear, which are of lower order in β than the usual magnetic-field gradient drift of the guiding-center theory. A dispersion relation for waves propagating parallel to the self-field and perpendicular to the applied field is derived and is expressed in terms of the Fried and Conte plasma dispersion function. In the limit of vanishing shear, i.e., no self-field, the dispersion relation reduces to the well-known result of Bernstein for quasi-electrostatic waves propagating perpendicular to a constant magnetic field in a homogeneous plasma. The gyroresonances, found in the Bernstein theory, are damped in the inhomogeneous sheet pinch due to gyro phase mixing. A low-frequency shear wave of the universal type is also found to be slightly damped. The stability is tested by means of a Nyquist plot. (auth)

17077 (TID-3557(Suppl.2)) CONTROLLED FUSION AND PLASMA RESEARCH. A Literature Search. Sidney F. Lanier, comp. (Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension). Jan. 1965. 572p. Dep. $6.00(CFSTI).

3657 annotated references to research reports and journal articles are cited, covering work on fusion reactions, plasma physics, magnetohydrodynamics, magnetic fields, and other topics related to research in controlled fusion. Report number, availability, and author indexes are provided. (auth)

17078 (TID-21380(p.31-6)) GEOPHYSICS. F. Bitter, G. Fiocco, T. Fohl, et al. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Experiments on the diffusion of plasma across homogeneous magnetic fields were continued. Results of experiments with Ar discharges, He discharges, and He-Hg low-pressure discharges are discussed. Conclusions based on these results are included. Experimental results are also given that establish Waymouth's theory for the perturbation of plasma by probes. An analysis of results obtained in line-shape studies of Hg resonance radiation at zero magnetic field is included. (J.R.D.)

17079 (TID-21380(p.45-61)) PLASMA PHYSICS. S. C. Brown, G. Bekefi, K. U. Ingard, et al. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research on impurity photoconduction of InSb in magnetic fields is described. Results indicate that the mechanism of impurity photoconductivity from the ground state of the donor atom to the second Landau-level conduction band accounts for the conductivity dependence of infrared-irradiated InSb in magnetic fields. Observations of steady-state characteristics of beam plasma discharge are reported, and possible loss mechanisms are discussed. The design, theory, and operation of a laser interferometer to measure dielectric constants in the visible and near infrared are described. (J.R.D.)

17080 (TID-21380(p.63-84)) PLASMA ELECTRONICS. L. D. Smullin, H. A. Haus, A. Bers, et al. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research on beam plasma discharge is reported. Modifications of the vacuum system of system C are described along with a computer display system for analyzing instabilities in plasma. An analysis of x rays emitted by electron cyclotron resonance discharge is presented. Results of continued work on scattering of laser radiation from plasmas are reported. Results of an investigation concerning the use of Thompson scattering as a plasma diagnostic method are also reported. (J.R.D.)

17081 EXPERIMENTS OF A QUASI-STEADY J × B ACCELERATOR. R. Leon Leonard and James A. Fay (Massachusetts Inst. of Tech., Cambridge). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 115-21(Jan. 1965).

The acceleration of partially ionized argon in a channel of constant cross-sectional area having a uniform applied transverse magnetic field and subject to a current normal to both the magnetic field and the channel axis was studied. The channel was operated in the manner of a shock tunnel with sufficient test time to achieve steady flow within the accelerator section. Visual observation of the flow within the channel and measurement of the electrical characteristics of the driving circuits established that substantial acceleration occurred in the channel. Flow velocities up to 12 km/sec were measured. The momentum increase of the gas within the accelerator was found to correlate with the theoretical impulse over the range studied. At the highest magnetic field strengths, a notable decrease in velocity, occurred as the gas left the magnetic field region at the downstream end of the accelerator. The current flowing through a laminar Hartmann boundary layer on the tube wall normal to the magnetic field was estimated and was sufficient to account for the failure to achieve the theoretical momentum increase in the accelerator. (auth)

17082 DETERMINATION OF MASS ERODED FROM PULSED PLASMA ACCELERATOR ELECTRODES. T. L. Rosebrock, D. L. Clingman, and D. G. Gubbins (General Motors Corp., Indianapolis). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 150-1(Jan. 1965).

A method was developed for the capture of plasma discharge products for subsequent determination of the eroded electrode mass, and the erosion of molybdenum and stainless steel electrodes was studied using silver wires as the propellant materials. The plasma momentum was also measured. (D.C.W.)

17083 HORIZONS IN PLASMA DYNAMICS. Arthur Kantrowitz (Avco Corp., Everett, Mass.). Astronaut. Aeronaut., 3: No. 1, 52-65(Jan. 1965).

Basic plasma principles and power potentials are discussed. Various applications of plasma such as crossed-field accelerators, MHD generators, rocket propulsion elements, arc-jet engines, and coaxial plasma guns are described. (R.E.U.)

17084 ON HIGH-FREQUENCY OSCILLATIONS EXCITED BY ELECTRON BEAM INTERACTIONS WITH PLASMA. A. K. Berezin, Ya. B. Fainberg, L. I. Bolotin, and G. P. Berezina. At. Energ. (USSR), 18: 5-14(Jan. 1965). (In Russian)

Oscillations excited by electron beam and plasma interactions were investigated under the conditions in which $\omega < \omega_H$ (where ω is the electron Langmuir plasma frequency and ω_H is the electron cyclotron frequency). Wave excitations in the beam and plasma, their frequency spectra, phase velocities, amplification coefficients, electric field intensity, and the spectral distribution of excited oscillations were determined. Experimental measurements of frequencies, amplification factors, and phase velocities were in agreement with theory. (tr-auth)

17085 INTERACTIONS OF PLASMA CLUSTERS WITH ELECTROMAGNETIC WAVES. V. I. Veksler, I. R. Gekker, E. Ya. Gol'ts, G. A. Delone, et al. At. Energ. (USSR), 18: 14-18(Jan. 1965). (In Russian)

Preliminary data are given on plasma acceleration in annular waveguides. Experiments were carried out in the 10 cm range in installations with the H_{01} and H_{11} type waves and with various plasma injectors. Plasma bunches with the initial particle concentrations of 10^{12} cm^{-3} and above were injected at a rate of 5×10^6 cm/sec. Electric probes, ultra high frequency methods, and electrostatic particle energy analyzers were used in plasma diagnostics. Plasma containment was achieved by various configurations of auxiliary external magnetic fields. Ion acceleration to over 10 kev was obtained. (tr-auth)

17086 INVESTIGATION OF THE RADIAL TEMPERATURE DISTRIBUTION AND THE VELOCITY OF FLOW IN A STATIONARY AND PULSE-MODULATED ARGON PLASMA BEAM AT ATMOSPHERIC PRESSURE. M. Looke, W. Neumann, and K. Rademacher (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin) Beitr. Plasmaphysik, 4: 239-62(1964). (In German)

The characteristics of stationary and pulsed argon plasma beams were determined at a maximum strength of the pulse current of 1100 amp. The radial temperature distribution was determined by means of time-resolving spectroscopy using a monochromator-multiplier-oscillographic arrangement. The axial and the radial velocity distribution of the plasma beam was determined from photographs taken with a movie camera which showed a bright-dark structure. An axial temperature of 1900°K was obtained for a pulse modulated beam. For stationary beams, the velocity was between 41 and 152 m/sec and for pulse modulated beams, between 330 and 3100 m/sec. The true gas-flow rate during a pulse was determined from photographs of the radial temperature and flow velocity profiles. It appeared to be considerably lower than the rate adjusted before the pulse. The intensity of the plasma beam, determined in the same way from temperature and velocity profiles for a gas flow of 0.145 g/sec and I = 1000 amp, was 15.5 kw or 49% of the total electric discharge. (OTS)

17087 THE DAMPING OF SOUND WAVES IN A DISCHARGE COLUMN OF A LOW-PRESSURE PLASMA. Erhard Hayess (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 211-19(1964). (In German)

The dependence of the damping of sound waves on the gas pressure and the current strength in xenon was investigated. The experimental device consisted of a discharge tube in which the plasma was distorted by means of an auxiliary electrode with high-potential square-wave pulses. The characteristics of the sound waves generated in this way were photoelectrically measured as the plasma was modulated by light. It was found that the strength of the discharge current had very little influence on the damping factor. An increase of gas pressure led, however, to a noticeable decrease in damping. The measurements were compared with theoretical results obtained by other investigators. They show that of all the mechanisms which can cause damping of the waves in a neutral gas, only the damping caused by the walls of a narrow pipe materially affected these measurements. The effective damping caused by collisions of charge carriers at a low ionization rate from (10^{-6} to 10^{-3}) can also be disregarded. (OTS)

17088 THE STABILITY OF A SELF-GRAVITATING SYSTEM WITH TWISTED MAGNETIC FIELDS. A. K. Sundaram (Indian Inst. of Tech., Bombay). Can. J. Phys., 43: 338-52(Feb. 1965).

The stability of a gravitating plasma column surrounded by a vacuum was investigated for the case in which both uniform volume and surface currents are present in the plasma. Some general criteria were obtained for long-wavelength perturbations, and the disturbance-growth-rate curves were drawn for different modes m. It was found that the stability of gravitating plasma is increased by the effect of both uniform volume current and external axial field for a specific range of values of b_0^2. Further, for certain criti-

cal values of b_1^2 much greater than 1.3, it was found that the instability sets in for the mode m = 1. Some general dispersion relations were also derived for the cases: when there are general magnetic field and current distributions; when the system is subjected to uniform and nonuniform angular velocities. In the case of axisymmetric disturbances whose wavelengths are assumed to be very large, it was found that the stability characteristics of the gravitating plasma are unaltered by the effect of uniform rotation. (auth)

17089 DISSIPATION OF ENERGY OF LOW FREQUENCY WAVES IN A WEAKLY IONIZED GAS. A. Hruska (Geophysical Inst., Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 15: 158-69(1965).

The properties of low-frequency waves in a slightly ionized gas are discussed on the basis of the Boltzmann transport and Maxwell equations. Special attention is paid to decay mechanisms forcing the gas to thermal equilibrium. It is shown that the collisional exchange of energy between ions and neutral atoms may considerably influence the dispersion equations of several modes of oscillations. (auth)

17090 VARIANT OF MAGNETIC TRAP. S. P. Lomnev (Computation Center, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 827-30(Oct. 11, 1964). (In Russian)

Calculated trajectories of nonrelativistic ions in a magnetic-dipole field, at velocities close to those used to obtain thermonuclear reactions are presented. It was concluded that the field of a magnetic dipole is capable of confining and accumulating heavy particles, and the field intensity required for this purpose is physically attainable. The time of flight of the particle between the poles and the amplitude of the radial oscillation can be controlled by varying the magnetic field intensity, the radius, and the injection energy. The necessary condition for particle capture can be created by superimposing a supplementary sinusoidal field. The results of previous investigation indicate that the Coulomb interaction will not be a major obstacle to the realization of such a magnetic trap. (ATD)

17091 EQUILIBRIUM OF PLASMA PINCH WITH HELICAL PERTURBATIONS. A. I. Morozov and L. S. Solovev. Dokl. Akad. Nauk SSSR, 158: 831-4(Oct. 11, 1964). (In Russian)

It is shown that the appearance of singularities in the linearized equations for perturbations of toroidal plasma configurations is connected with a qualitative rearrangement of the structure of the magnetic surfaces, and that arbitrarily small static perturbations can lead to finite changes in plasma configurations and thus noticeably affect their stability. The configurations considered are: cylindrical magnetic surfaces with helical perturbations; equilibrium helical plasma configurations; and forcefree plasma configuration. The first case results in a wavy magnetic-surface structure with the elliptic and hyperbolic singular points lying on circles. In the second case it is shown that, depending on the choice of the initial equilibrium configuration, the development of instability reduces to the formation of a stable filamentary plasma structure. In the case of a force-free plasma configuration it becomes possible to obtain the stability conditions for a plasma supported by an ideally conducting liner. (ATD)

17092 WAVE INTERACTION IN CONTINUOUS MEDIA. A. A. Vedenov and L. I. Rudakov. Dokl. Akad. Nauk SSSR, 159: 767-70(Dec. 1, 1964). (In Russian)

It is shown that interactions occurring in continuous media between collective oscillations belonging to different vibrational branches, and as a rule differing greatly in frequency, can be described with the aid of a self-consistent system of equations comprising the kinetic equation for the distribution function of the high frequency waves (in six-dimensional space of the coordinates and wave vectors) and equations of the hydrodynamic types for the variations of the density, velocity, and pressure of the material. This system of equations can be used to investigate processes whose periods and wavelengths greatly exceed the period and wavelength of the high-frequency oscillations. The equations contain only average characteristics of the high-frequency waves, which under these conditions can be regarded as quasiparticles. The resultant self-consistent system, which describes the interaction between the high-frequency oscillations (quasiparticles) and the field of the low-frequency waves, is used to calculate several effects in an isotropic plasma with hot electrons. This includes the damping of the ionic-sound wave in a gas of Langmuir plasmons, the instability of a cold gas of Langmuir plasmons, the criterion for instability of a hot plasmon gas, and the interaction of plasmons with a random field of ionic-sound waves. (ATD)

17093 CONCERNING THE HEATING OF ELECTRONS IN AN ANISOTROPIC PLASMA. V. I. Pistunovich and A. V. Timofeev. Dokl. Akad. Nauk SSSR, 159: 779-81(Dec. 1, 1964). (In Russian)

It is shown that the instability relative to the buildup of potential oscillations, observed previously in low-pressure plasma with an anisotropic distribution of ion velocity, is developed on the negative-energy oscillation branch and that its development should be accompanied by intense absorption of energy by resonant electrons (Landau damping). The analysis is carried out for an anisotropic, collisionless, and spatially homogeneous plasma in a magnetic field. The results indicate that the anomalous heating of electrons, observed in adiabatic traps, may be due to the buildup of this instability. In the case of a dense plasma, dissipative instability can develop as a result of collisional dissipation of energy and can lead to a similar instability. (ATD)

17094 DISCRETE MODEL OF MATTER IN A PROBLEM OF RAREFIED PLASMA FLOW AROUND A BODY. M. V. Maslennikov and Yu. S. Sigov. Dokl. Akad. Nauk SSSR, 159: 1013-16(Dec. 11, 1964). (In Russian)

A discrete model method was used to calculate the self-consistent electrostatic field around an axisymmetric body moving in a neutral, rarefied plasma with speed v. It is assumed that the incident ions are absorbed on the surface Σ and the charge distribution in space is given by the sum of electron and ion densities, $\rho(r) = \rho^E(r) + \rho^I(r)$. It is further assumed that ρ^E is uniquely determined by the given self-consistent potential ϕ and ρ^I at the same point r: $\rho^E = F(\phi,\rho^I)$. The calculation is carried out in cylindrical coordinates for ion trajectories determined by the collisionless Vlasov equation, which for this particular case reduces to Newton's equation $\ddot{r}_k = -(Ze/M)\nabla\varphi(r_k)$ with initial conditions $r_k(0) = r_k^0$, $\dot{r}_k(0) = v$, k = 1,2, ... N. The ion density is represented by a summation over the r0z plane and the Poisson equation is written in the form $\Delta\varphi(r) = -4\pi[\rho^I(r) - F(\varphi(r),\rho^I(r))]$ with boundary conditions $\phi = \phi_\Sigma$ at $r\epsilon\Sigma$; $\partial\varphi(r)/\partial r = 0$ at r = 0. The above equations are solved numerically using the method of successive approximations starting with a zeroth approximation $\phi^0(r)$. A smoothing operator $\hat{P}$ is introduced ($\hat{P}\rho^I(r) = \min\{q,\rho^I(r)\}$, q = const > 0) to suppress local perturbations on ρ^I. For a Maxwellian distribution in ρ^E it is shown that convergence is guaranteed if $(Mv^2/2) > \vartheta kT_eZ$, where θ grows as the volume V_Ω increases in the domain Ω. Numerical results are quoted for the case of a sphere R = 50 cm, $\phi_\Sigma = 0$, $T_e = 5000°K$, $T_i = 0$, Debye length = R, and $v = 10^8$ cm/sec. The equipotential curves are plotted on a r/D versus z/D plane. It is found that several Debye distances behind the body an electron trail exists accompanied by a potential well with maximum depth 0.5 kT_e. (ATD)

17095 DISSOLUTION OF HYDROGEN SPECTRAL LINES AT HIGHER ION DENSITIES. Vladis Vujnovic (Univ. of Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 19: 97-110(1964).

A dissolution factor is evaluated for measuring depopulation (preionization) of electron levels in strong unhomogeneous fields in a plasma. The evaluation is accomplished by constructing line profiles (in an approximate manner) for the case with dissolution and without it. The ratio of the areas under the profiles with dissolution and without dissolution, gives the dissolution factor W_n. (auth)

17096 CONVECTIVE INSTABILITY OF A HYDROMAGNETIC FLUID WITHIN A RECTANGULAR CAVITY. Ulrich H. Kurzweg (United Aircraft Corp. Research Labs., East Hartford, Conn.). Intern. J. Heat Mass Transfer, 8: 35-41(Jan. 1965).

The onset of convection in an electrically conducting fluid confined within an infinite cavity of rectangular cross section was examined for the case when the fluid is subjected to both a vertical temperature gradient and a vertical magnetic field. Characteristic value equations governing fluid stability were derived and a modified Fourier technique was used to solve them. The critical temperature gradient at the onset convection was found to be a function of the Hartmann number and of the cavity aspect ratio. (auth)

17097 SATURATION ION CURRENTS TO LANGMUIR PROBES. Francis F. Chen (Princeton Univ., N. J.). J. Appl. Phys., 36: 675-8(Mar. 1965). (MATT-272)

The parabolic variation of saturation ion current with probe potential observed in dense plasmas is fortuitous and is not directly related to the effects of orbital motion. Agreement between measured and computed saturation ion characteristics is illustrated. The discussion is in the framework of collisionless, magnetic-field-free theories; they apply to the experiments only if the ion Larmor radius is much larger than the probe radius. (auth)

17098 INVESTIGATION OF HOT OPAQUE ARC PLASMAS BY MICROWAVE CAVITY TECHNIQUES. W. T. Maloney (Harvard Univ., Cambridge, Mass.). J. Appl. Phys., 36: 703-11(Mar. 1965).

The behavior of a steady-state Ar arc plasma flowing through a cold 1-cm circular copper pipe at pressures from 0.1 to 1 atm and gas flow rate of 2600 ml/min is studied by microwave cavity techniques. The high electron density ($n_e > 10^{16}$ cm^{-3}) and large density gradients in the arc preclude the usual simple interpretation of data. At this density it is however possible to interpret the cavity resonant frequency as a measure of the "diameter" of the arc column. Experimental results show the dependence of this diameter on pressure, arc current, and the presence of contaminant gases in concentrations as small as 10 ppm. A simple explanation of the influence of diatomic contaminants is given which attributes column contraction to enhanced thermal conductivity brought about by diffusion of dissociation energy. Dilation of column caused by krypton is attributed to enhanced electron concentration in the cooler regions of the plasma due to krypton's lower ionization potential. Calculations of thermal conductivity of argon-contaminant mixtures are shown to correlate well with the experimental results. (auth)

17099 RESISTIVITY OF XENON PLASMA. John H. Goncz (Edgerton, Germeshausen and Grier, Inc., Bedford, Mass.). J. Appl. Phys., 36: 742-3(Mar. 1965).

By measuring the voltage drop in xenon flashtubes, the resistivity of intense xenon plasmas was found to bear an inverse square root relation to the current density. A weak dependence on pressure is discussed. (auth)

17100 ULTRAVIOLET LIGHT EMISSION FROM TOWNSEND DISCHARGES IN HYDROGEN. Kaare J. Nygaard (Norges Tekniske Hogskole, Trondheim, Norway). J. Appl. Phys., 36: 743-6(Mar. 1965).

The total ultraviolet radiation from self-sustained Townsend discharges in hydrogen was measured by means of a sodium salicylate wavelength shifter and a photomultiplier tube. The excitation coefficient per unit pressure δ_0/p was determined for E/p = 80–250 v/torr-cm. δ_0/p as a function of E/p passes through a maximum for E/p ≈ 150 v/torr-cm. The pressure dependence of the radiation can be ascribed to quenching with a quenching pressure equal to 20 torr. An attempt was made to evaluate separately the excitation coefficient for the $2^1\pi_u$ radiation by subtracting other u-v contributions from the total light intensites observed. (auth)

17101 MODES OF THE SCREW INSTABILITY IN A POSITIVE COLUMN WITH LONGITUDINAL MAGNETIC FIELD. Satoshi Itoh, Motoichi Kawaguchi, and Kenzo Yamamoto (Nagoya Univ., Japan). J. Appl. Phys., 36: 754-8(Mar. 1965).

The modes of screw instability in a positive column of a nitrogen gas discharge were studied. Under a certain condition, the critical magnetic field for the m = 2 mode was found to be smaller than that for the m = 1 mode. In addition, the regular oscillations were observed at the magnetic field larger than the critical one. These phenomena cannot be described by the results of Kadomtsev and Nedospasov which are calculated from the small-amplitude theory. A theoretical explanation for these phenomena is proposed, based on the conception that only the instability which has the maximum growth rate can grow while other instabilities are masked. (auth)

17102 SOME CONSTANTS OF THE LINEARIZED MOTION OF VLASOV PLASMAS. C. Oberman (International Centre for Theoretical Physics, Trieste, Italy) and M. Kruskal. J. Math. Phys. (N. Y.), 6: 327-35(Mar. 1965). (MATT-253)

A new class of nonlocal constants for the linearized Vlasov equations is presented. These are constants which, in general, are not expressible as simple phase-space integrals of a locally defined integrand. The relevance of these constants to stability considerations is indicated. (auth)

17103 ON THE POINT OF EMERGENCE OF A MICROWAVE BEAM ENTERING A LINEARLY GRADED PLASMA. A. L. Cullen (Univ. of Sheffield, Eng.). J. Res. Natl. Bur. Std., 69D: 177-8(Feb. 1965).

A beam of microwave radiation is assumed to enter a linearly graded plane-stratified plasma. If the electron density reaches the critical value $\omega^2\epsilon_0 m/e^2$ at a distance x_c from the plasma boundary, ray theory predicts that the beam will emerge from the plasma at a distance $2x_c \sin 2\theta$ from its point of entry, θ being the angle of incidence. The validity of this result is studied using wave theory. (auth)

17104 EFFECT OF ELECTRON COLLISIONS ON THE FORMULAS OF MAGNETO-IONIC THEORY. K. G. Budden (Cambridge Univ., Eng.). J. Res. Natl. Bur. Std., 69D: 191-211(Feb. 1965).

In the standard simple treatment of magneto-ionic theory the effect of collisions is allowed for by assuming that an electron experiences a retarding force proportional to its velocity, and the two complex refractive indices of an ionized medium are then given by the Appleton-Hartree formula. Experiments have shown, however, that the collision frequency is approximately proportional to the square of the electron's velocity, and proper allowance for this, using the Boltzmann equation, leads to a modification of the Appleton-Hartree formula which was given by Sen and Wyller. The same modified formula is derived, but by a different method. Some numerical results are presented in which the modified and unmodified formulas are compared. It is concluded that the standard Appleton-Hartree formula can be used without modification for nearly all radio propagation problems in the ionosphere, provided that the correct effective value of the collision frequency is used. The modifications may be important, however, in the theory of wave interaction and for waves of very low frequency whose wave normals are perpendicular to the earth's magnetic field. (auth)

17105 DISCUSSION ON BASIC EQUATIONS WITH SOURCE TERMS IN COMPRESSIVE AND INCOMPRESSIVE PLASMAS. Kun-mu Chen (Michigan State Univ., East Lansing). J. Res. Natl. Bur. Std., 69D: 243-5(Feb. 1965).

It is shown that the same set of basic equations with source terms can and should be applied to both a compressive and an incompressive isotropic plasma. In a compressive plasma, an electric source can excite an electroacoustic wave. In an incompressive plasma, however, this electroacoustic wave reduces to an accumulation of charges shielding the electric source. The physical meaning of the dielectric constant of an incompressive plasma is discussed.

and the physical model of an incompressive plasma is re-examined. (auth)

17106 SCATTERING OF ELECTROMAGNETIC AND ELECTROACOUSTIC WAVES BY A CYLINDRICAL OBJECT IN A COMPRESSIBLE PLASMA. James R. Wait (National Bureau of Standards, Boulder, Colo.). J. Res. Natl. Bur. Std., 69D: 247-56(Feb. 1965).

The theory of wave propagation in an inhomogeneous compressible plasma is considered. Cylindrical configurations are chosen such that Maxwell's equations, when combined with a (single fluid) continuum theory of fluid dynamics, are separable. It is shown that general expressions for the fields are superpositions of transverse magnetic, transverse electric, and acoustic waves. For oblique incidence, these three wave types are mutually coupled except in special cases. (auth)

17107 ON THE PROPAGATION MODES OF ELECTROMAGNETIC WAVES IN MAGNETOACTIVE PLASMA. Kunlaki Sakurai (Kyoto Univ.). Kakuyugo Kenkyu, 12: 10-23 (Jan. 1964). (In Japanese)

There are two modes of electromagnetic wave propagation in a magnetoactive plasma, left-handed and right-handed waves. The propagation modes of electromagnetic waves are defined from the direction of the magnetic vector rotation of the wave. These two propagation modes are called the ordinary and extraordinary modes, respectively. The latter mode, when propagating in the direction of the applied magnetic line of force, coincides with the direction of the electron gyration vector. In the paper, only the case of electromagnetic wave propagation for $f_p > f_H$ is treated. According to the magneto-ionic theory, the direction of magnetic vector rotation of the extraordinary wave accords with that of the electron gyration when the wave frequency (f) is larger than the plasma frequency of the medium (f_p), but for the case $f < f_p$ these two directions do not accord with each other. This results from the fact that the characteristic refractive index of the medium reverses with f to the case $(f/f_p)^2 > 1$ or <1. In the case $f < f_p$, only one right-handed wave (Whistler mode) can exist when $f_{Hi} \leq f < f_H$ (f_H, electron gyrofrequency; f_{Hi}, ion gyro-frequency), and for $f < f_{Hi}$ both propagation modes exist again. The results deduced from the dispersion equation show that the right-handed mode is "ordinary" and the left-handed mode is "extraordinary." This definition is opposite to that in the case $f > f_p$. This conclusion is not consistent with the definition used at the present. The definition of the propagation modes described above is favorable for the interpretation of the guidance characteristics of electromagnetic waves in a magnetoactive plasma. The examination of the guidance characteristics shows that the definition of the propagation modes shown is reasonable. (auth)

17108 OBSERVATION OF CUSP INJECTION WITH A MAGNETIC PROBE. Atsuhiko Ozaki (Osaku Univ.). Kakuyugo Kenkyu, 13: 143-59(Aug. 1964). (In Japanese)

Studies of plasma injection into cusped geometries using magnetic probes are reported. From measurements of the variation of axial field, B_z, it was found that injected plasmas excluded B_z up to 5 kG and the plasma was trapped inside the magnetic bottle when the exit cusp was more than 9 kG. Radial variations of the field were also measured and instantaneous distributions were obtained. As an auxiliary measurement, a Kerr-cell camera was also available. A number of shots confirmed behaviors of plasmas observed from magnetic probes. (auth)

17109 SPECTROSCOPIC MEASUREMENTS OF THE PLASMA FROM A PLASMA GUN. PART I. Nobuki Kawashima and Kenji Inoue (Japan Atomic Energy Research Inst., Tokyo). Kakuyugo-Kenkyu, 13: 324-35(Sept. 1964).

Line broadenings of He I 4471 and He II 4686 in the plasma generated in a Marshall-type coaxial plasma gun are measured by a 340-cm Ebert-type spectrometer. According to the Doppler shift measurement, a plasma is accelerated for about 5 μsec after the initiation of the gun discharge, and it leaves the plasma gun, while an unaccelerated plasma remains in the plasma gun after the discharge. Most of the line broadening in He II 4686 is due to Doppler broadening, and the Stark broadening is negligible. The accelerated plasma from the gun gradually loses the perpendicular component of the velocity to the axis of the plasma gun as it travels. (auth)

17110 COLLISION-INDUCED INSTABILITY IN A MAGNETOACTIVE PLASMA. Noboru Shimomura (Kyoto Univ.) and Shigetoshi Tanaka. Kakuyugo-Kenkyu, 13: 336-49(Sept. 1964). (In Japanese)

The dispersion laws for the waves propagating in a magnetoactive plasma are obtained, using the Boltzmann equation with a collision term representative of isotropic, recoilless, elastic, binary scattering of the electrons. The two cases (I)M; $K \parallel B_0$ and (II); $K_i B_0$ are studied, where K and B_0 are the wave vector and the uniform external magnetic field. Assuming a δ-function for the velocity distribution function the dispersion laws for a long wavelength limit are classified as follows: $\omega(\omega + i\nu)^2 = \omega_p^2 [\omega + i\nu - i(V/3)(d\nu/dV)]$ and $\omega(\omega \pm \omega_c + i\nu)^2 = \omega_p^2 [(\omega \pm \omega_c + i\nu - i(V/3)(d\nu/dV)]$ where ω_c, ω_p and ν are the cyclotron, the plasma, and the collision frequency respectively. After some calculations under the assumption $\nu(V) = \text{const} \times V^h$, it is found that the initial disturbance grows for $h < 3$ and $\text{Im}(\omega)$ attains its maximum value at $\text{Re}(\omega) = \omega_c$. (auth)

17111 QUASI-STATIC WAVES IN INHOMOGENEOUS MAGNETOPLASMA SLABS. P. de Santis (Selenia S.p.A., Rome). Nuovo Cimento (10), 35: 823-37(Feb. 1, 1965).

Starting from Maxwell's equations, a theoretical investigation of the propagation of a quasi-static E-mode in a longitudinally magnetized plasma slab is made. A transmission-line equation is obtained for the electric field and the Ritz-Rayleigh variational method is used to minimize the error over the cross-section of the slab, when a trial function for the field distribution in the plasma is assumed. A parabolic distribution is taken as an analytical model for the electron-density profile in the cross section, and the electron density is supposed to vanish at a point outside the plasma slab; in the limit for the zero point to go to infinity, uniform case-equations are recovered. Under these conditions, a dispersion relation is derived, and dispersion curves are calculated and plotted for some numerical cases of interest. In the homogeneous case a comparison is made between the approximate solutions and the exact solutions. (auth)

17112 BOUNDARY CONDITIONS FOR PLASMA ION WAVES. B. Bertotti and A. Cavaliere (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 35: 1244-6(Feb. 16, 1965).

The boundary conditions for ion waves in low-pressure discharges are studied, with specific consideration of the space-charge sheath. It is shown that Bohm's condition is valid even when oscillations are present. (D.C.W.)

17113 A NOTE ON PLASMA OSCILLATIONS IN A MAGNETIC FIELD. A. K. Rajagopal (Harvard Univ., Cambridge, Mass.). Nuovo Cimento (10), 36: 279-83 (Mar. 1, 1965).

An alternative derivation (Phys. Letters, 5: 40(1963)) of the dispersion relation for the longitudinal oscillations of a plasma in a uniform field is discussed. Earlier results are generalized by developing a method for computing all the components of the current-current and current-density correlation functions. These are useful in discussing the magnetoresistance effects and helicon modes. The variational derivative technique is used. The formalism is of sufficient generality as to include the case of Bloch electrons. (C.E.S.)

17114 ELECTRON INTERACTIONS IN CRYOGENIC HELIUM PLASMAS. Paul D. Goldan and L. Goldstein (Univ. of Illinois, Urbana). Phys. Rev., 138: A39-44 (Apr. 5, 1965).

Microwave-propagation and microwave-interaction techniques were used to determine the electron collision frequency for momentum transfer in helium for electron energies in the vicinity of 0.001 ev. Measurements of the complex microwave conductivity and electron-energy re-

laxation rates were performed in the afterglow of a pulsed discharge in helium in the pressure range 0.1 to 5 torr submerged in a bath of liquid helium at 4.2°K. Electron-radiation temperature measurements during plasma decay demonstrated monotonically decreasing electron temperatures as a function of time. For times when an extrapolation of the electron temperature decay indicated near thermal equilibrium with the parent gas, a momentum-transfer cross section in the range 10×10^{-16} to 19×10^{-16} cm^2 was determined. Measurements of electron-energy relaxation rates for atomic densities exceeding 2.3×10^{18} cm^{-3}, where the electron de Broglie wavelength is becoming long in comparison to the average inter-scatterer spacing, indicate the limit of validity of binary-collision concepts. (auth)

17115 NONLINEAR DYNAMICS OF LONGITUDINAL OSCILLATIONS IN A HOMOGENEOUS COLLISIONLESS PLASMA WITH AN EXTERNAL MAGNETIC FIELD. R. E. Aamodt (General Dynamics Corp., General Atomic Div., San Diego, Calif.). Phys. Rev., 138: A45-50(Apr. 5, 1965).

The effect of wave-wave scattering of longitudinal oscillations in a homogeneous collisionless plasma with an external magnetic field is derived. The nonlinear dynamics of the modes existing near multiples of the electron cyclotron frequency are discussed, and it is shown that resonant wave-wave scattering of unstable low harmonic modes is an important mechanism for transferring energy to the higher harmonics. (auth)

17116 HIGH-FREQUENCY CONDUCTIVITY OF A PLASMA IN QUASIEQUILIBRIUM. I. FORMULATION OF THE GENERAL THEORY. Ching-sheng Wu (California Inst. of Tech., Pasadena). Phys. Rev., 138: A51-7(Apr. 1965).

A general expression for the high-frequency conductivity is derived from the Bogolyubov-Born-Green-Kirkwood-Yvon hierarchy for a fully ionized plasma whose unperturbed state is stable. The result includes all the effects due to the high-frequency field and the collective interactions up to first order in the plasma parameter. (auth)

17117 CURRENT EDDIES AND CRITICAL SURFACES IN MAGNETOHYDRODYNAMIC FLOW. L. M. Alekseeva and L. S. Solovev. Prikl. Mat. i Mekhan., 28: 987-95(Nov.-Dec. 1964). (In Russian)

The steady-state axisymmetric flow of an ideal conducting plasma across an azimuthal magnetic field H is studied analytically to investigate singular points on the family of current curves rH_φ = const and to calculate the form of the critical curve where v becomes equal to the propagation speed $c_s = \sqrt{c_T^2 + H_\varphi^2/4\pi\rho}$. The flow velocity is assumed to have two components v_r and v_z; physically, the problem corresponds to the flow between two electrodes. It is assumed that the magnetic pressure is small compared to the gas pressure and that the flow changes slowly along the z-axis. The stability of the flow is investigated up to order ϵ. It is shown that for stability relative to axisymmetric perturbations the derivative of H^2/r^2 must be negative, and for helical stability, $(rH^2)'$ should be negative. (auth)

17118 EFFECT OF LARMOR GYRATION OF CHARGED PARTICLES ON UNSTEADY STATE TEMPERATURE FIELD IN SHALLOW CHANNEL. E. G. Sakhnovskii. Prikl. Mat. i Mekhan., 28: 1143-6(Nov.-Dec. 1964). (In Russian)

The temperature distribution in a cross section of a shallow channel with constant wall temperature and constant pressure drop was determined analytically. The energy equation is written under the conditions of incompressible flow, constant degree of ionization, and small magnetic Reynolds number. It is given in the form $(\partial T/\partial t) = C^2(\partial^2 T/\partial z^2) + F(z,t)$ where F(z,t) is a function of viscous dissipation and joule effect. The nonhomogeneous part of the equation is considered to be an even-function of z, and in the absence of any external electric fields, the solution for T(z,t) is given as the sum of $T_n(z)$ – viscous dissipation, T(z) – joule heating, and $T_t(z,t)$ – the time-dependent component of T. The resulting equation is very complicated in form; it includes both periodic and aperiodic components in time. The former is due to the Larmor gyration $\omega_e\tau_0 \sim 1$. Analysis of the equation indicates that: in an isotropic MHD flow ($\omega_e\tau_0 \ll 1$), the damping coefficient increases relative to the purely hydrodynamic flow case; the anisotropic electrical conductivity is lower than the isotropic conductivity; and in a fully ionized case, Larmor gyration lowers the damping coefficient. (auth)

17119 EFFICIENT LOW PRESSURE SPUTTERING IN A LARGE INVERTED MAGNETRON SUITABLE FOR FILM SYNTHESIS. W. D. Gill and Eric Kay (International Business Machines Corp., San Jose, Calif.). Rev. Sci. Instr., 36: 277-82(Mar. 1965).

Electrical and sputtering characteristics of a 10-cm-diameter inverted magnetron configuration were investigated in the transition region from positive to negative space-charge modes. Radial voltage and ion energy distributions were obtained for both modes. The positive space-charge mode resulted in the most efficient transport of sputtered material from cathode to anode. Dependence of space-charge sign reversal on apparatus dimensions and magnetic field strength are discussed, showing that operation in the 10^{-5} torr range can be expected for a 40-cm-diameter configuration. The deposition profile at the anode was in good agreement with the calculated profile, showing that ion current and hence sputtering is uniform over the effective cathode area. (auth)

17120 EXTENSION OF PLASMA INTERFEROMETRY TECHNIQUE WITH A He–Ne LASER. D. A. Baker, J. E. Hammel, and F. C. Jahoda (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 36: 395-6(Mar. 1965). (LA-DC-6547)

The density of the fast plasma component of a coaxial plasma gun was measured using a He–Ne laser together with both an external rotating mirror and an infrared detector. (D.C.W.)

17121 EXAMINATION OF HIGH FREQUENCY OSCILLATIONS IN A PLASMA. F. G. Zvereva. Uch. Zap. Kuibyshevsk. Gos. Ped. Inst., No. 42, 61-74(1964).

Oscillations induced in a limited plasma by a stream of primary electrons emitted by a cathode are studied in the 200-2000 Mc and 7800-11,200 Mc ranges. It is shown that oscillations are observed in the limited plasma even without an auxiliary electron beam. The intensity distribution of these oscillations in the interelectrode space is given, together with the intensity as a function of the discharge current of 550 to 950 mamp and the tube voltage of 40 to 120 v. The experimental data agree satisfactorily with the theory of excitation of oscillations in a plasma by an unmodulated electron beam. (OTS)

17122 ON THE PROPAGATION OF NON-STATIONARY LONGITUDINAL WAVES IN AN ISOTROPIC PLASMA. V. F. Aleksin and V. I. Yashin (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 9: 839-45(Sept. 1964). (In Ukrainian)

Propagation of nonstationary longitudinal waves in an isotropic relativistic medium, arising as a result of perturbation of the density of charged particles was studied. The shape and velocity of the signal propagation were investigated. (auth)

17123 ON THE DIFFICULT FORM OF DISCHARGE WITH ELECTRON OSCILLATIONS IN A MAGNETIC FIELD. E. T. Kucherenko and V. A. Sayenko (Kiev State Univ.). Ukr. Fiz. Zh., 9: 914-16(Sept. 1964). (In Ukrainian)

An attempt was made to determine the influence of fast electrons from a reflecting cathode on the static and dynamic characteristics of complex types of discharge events involving electron oscillations. The mean free path of the electrons in the cases considered was much larger than the discharge gap. The uneven distribution of the fast-electron density created difficulties concerning the discharge of the slow electrons. The experiment revealed the presence of a negatively charged volume in the anode region under certain magnetic field conditions. The presence of the negatively charged volume was shown by a minimum discharge, indicating that the appearance of the negative charge is

caused by fast electrons and is not due to slow electrons, as it was assumed in the past. (TTT)

17124 SIMILARITY SOLUTIONS IN UNSTEADY BOUNDARY LAYER THEORY IN MAGNETO-FLUID DYNAMICS. Ingolf Teipel (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Z. Angew. Math. Phys., 15: 588-97(Nov. 25, 1964).

Similarity solutions of the unsteady boundary layer equation were investigated, assuming the external magnetic field to be perpendicular to the main stream and the electric conductivity to be small. A set of new similarity solutions were obtained, using a space and time dependent magnetic field. Five special cases are discussed, and the possibility of introducing a constant magnetic field is considered. (tr-auth)

17125 MEASUREMENT OF THE RADIAL ELECTRON DENSITY DISTRIBUTION IN A PLASMA COLUMN WITH THE HELP OF MICROWAVES. Walther Hess (Technische Hochschule, Stuttgart). Z. Angew. Phys., 18: 68-70(Nov. 16, 1964). (In German)

A method is derived for determination of the radial electron density distribution in a plasma column. The plasma column was inserted in various plasma wave resonators, and the resonator detuning caused by it was measured. The electron density distribution was developed in a system of orthogonal polynomials, the development coefficients of which were calculated from the various frequency detunings. The method was tested experimentally on a low-pressure discharge in neon. (tr-auth)

17126 CORRELATION FUNCTIONS OF A SYSTEM WITH DIFFERENT TEMPERATURES OF THE PARTICLE COMPONENTS. G. Ecker and W. Kroell (Univ. of Colorado, Boulder). Z. Naturforsch, 19a: 1447-51(Dec. 15, 1964).

The electron-electron, electron-ion, and ion-ion pair distribution functions for a plasma in which the components have different temperatures are derived from the BBGKY hierarchy. (D.C.W.)

17127 POPULATION DENSITY OF EXCITED He(I) ATOMS IN A NONTHERMAL PLASMA. Hans-Werner Drawin (EURATOM-CEA, Fontenay-aux-Roses, France). Z. Naturforsch., 19a: 1451-60(Dec. 15, 1964). (In German).

The population densities of the lower levels of He I in a nonthermal, optically thin as well as a partially optically thick plasma were obtained by solving the corresponding rate equations. Due to the metastable 2^3S state, distinction was made between the singlet and triplet systems. Coupling between the two systems was provided by appropriate collision processes. Numerical values are given for the population densities for both the lower singlet and triplet levels in the case of an optically thin plasma. The relaxation times necessary for establishing a steady state were also calculated, and the effect of the triplet system on the particle densities of the singlet system was determined. (D.C.W.)

17128 ELECTRON PRESSURE AND TEMPERATURE IN MIXED PLASMA. D. Frhr. v. Dobeneck, J. Hingsammer, W. Kessler, and H. Krempl (Technische Hochschule, Munich). Z. Physik, 183: 140-5(1965). (In German)

In a thermal plasma, consisting of one component only, it is possible to calculate an accurate relation between electron pressure and temperature. An attempt is made to obtain an approximate solution for plasmas composed of several elements under condition that the electron pressure is less than 10% of the atmospheric pressure and that only one element is singly ionized. The results are controlled by measuring the temperature in a copper arc with addition of alkali or earth-alkali elements. Theory and experiment show that the ionization potential divided by the temperature is a constant term in the plasma for certain groups of elements. (auth)

17129 MEASUREMENT OF THE DENSITY OF A PLASMA DECAYING IN A MAGNETIC FIELD WITH AID OF MICRO-RADIO WAVE INTERFEROMETERS AND A FABRY–PEROT INTERFEROMETER. P. I. Blinov, S. P. Zagorodnikov, G. E. Smolkin, and G. V. Sholin. Zh. Eksperim. i Teor. Fiz., 48: 61-4(Jan. 1965). (In Russian)

The density of a plasma decaying in a magnetic field was measured in the interval from 7×10^{11} to 4×10^{13} cm^{-3} with micro-radio wave interferometers at wavelengths of 8 and 4 mm. At densities above 4×10^{13} cm^{-3} the plasma density was measured on basis of the Stark effect of the hydrogen Balmer lines. The time dependence of the electron density of a plasma decaying in a magnetic field was measured with help of these techniques. (auth)

17130 MAGNETO-ACOUSTIC RESONANCE IN A TOROIDAL SYSTEM. I. A. Kovan, L. L. Kozorovitskii, V. D. Rusanov, V. P. Smirnov, and D. A. Frank-Kamenetskii. Zh. Eksperim. i Teor. Fiz., 48: 72-7(Jan. 1965). (In Russian)

Magneto-acoustic resonance is observed in a toroidal system with a longitudinal current when a small amplitude excitation is superimposed. The resonance frequency is close to the calculated value; however the increase of the magnetic sound amplitude along the column axis was not very significant. The effect may be employed for high frequency heating of a plasma in toroidal systems with a strong magnetic field. (auth)

17131 ON STABILIZATION OF TROUGH INSTABILITY OF A PLASMA BY AN INHOMOGENEOUS ELECTRIC FIELD. A. A. Rukhadze and I. S. Shpigel (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 151-7 (Jan. 1965). (In Russian)

Stabilization of trough instability by an inhomogeneous electric field is investigated in the two-liquid hydrodynamics model. Cases of plane and cylindrical geometry of an inhomogeneous plasma are considered. Dispersion relations in the geometric optics approximation are obtained which yield the trough oscillation spectra; local criteria for stabilization of trough instabilities are established. It is demonstrated that effective stabilization of plasma surface instabilities is possible under conditions when the size of the electric field inhomogeneities is smaller than the characteristic size of the plasma inhomogeneity (i.e., the transverse dimension of the plasma) and the field itself is larger or comparable to the thermal field. Stabilization is independent of the sign of the electric field and is due to distortion of the trough shape during a time which is smaller than the time of development of trough instability. (auth)

17132 INSTABILITY OF A POSITIVE COLUMN IN A MAGNETIC FIELD AT LOW PRESSURE. V. V. Vladimirov. Zh. Eksperim. i Teor. Fiz., 48: 175-84(Jan. 1965). (In Russian)

Instability of a low pressure positive column which is not directly related to the current or collisions with charged particles is considered. The instability of an inhomogeneous plasma considered here arises if ionization and transfer of perturbations in an ambipolar field are taken into account; in particular, build-up of a purely azimuthal wave $m = 1$, $k_z = 0$ whose phase velocity is close to the ion flow rate in the ambipolar field may take place. The condition for generation of the instability under consideration is similar to that observed experimentally. The instability mechanism may also be operative in a strongly ionized plasma. (auth)

17133 ANALYZER FOR THE ENERGY SPECTRUM OF IONS IN HIGH-TEMPERATURE PLASMA. Yu. V. Gott and V. G. Tel'kovskii. Zh. Tekhn. Fiz., 34: 2114-19(Dec. 1964). (In Russian)

One of the significant characteristics of high-temperature plasmas, which is of particular interest in thermonuclear research, is the energy distribution of the ions. However, present techniques for determination of the ion spectrum (optical procedures, high-frequency methods, ion traps, and thin foils) all suffer from more or less serious shortcomings. Accordingly, there is proposed a technique and the design of an appropriate apparatus for ion spectrum measurements. The new departure is use of an ultrathin metal foil instead of a gas target, which makes possible substantial simplification of the installation. The analyzer is illustrated. The neutral particles are incident on the ultrathin foil; the ions, forming incident to passage of the neu-

trals through the foil, are analyzed in energy in the field of the electrostatic capacitor. To increase the angular aperture the capacitor plates have a special shape that allows double focusing of the ion beam. The foil window in the constructed analyzer measures 5 × 20 mm. The energy distribution is measured either by applying a sawtooth voltage to the capacitor plates to obtain a scan or at individual points, narrow energy groups being isolated by applying an appropriate d-c bias from the rectifier to the capacitor plates. After the capacitor, the ions pass through the aperture, are accelerated by the 5-kv potential difference and strike the first dynode of the electron multiplier; the multiplier signal is amplified by the wide-band amplifier and either fed into the PS-10,000 scaler via the time discriminator or applied to the plates of the oscillograph. A cross sectional view of the analyzer chamber is given. The choice of foil is discussed; silver foil 100-200 Å thick was used in the constructed analyzer. The analyzer was used to investigate the distribution in energy of ions in an adiabatic trap with magnetic mirrors. The results are presented in the form of curves; the distributions obtained with fields of 5 and 8 kOe at the center of the trap are close and consistent with the distribution determined otherwise. Particles with energies down to 40 ev were recorded. It is noted that the reported measurements were intended primarily to verify the potentialities of the technique. (ATD)

17134 INSTABILITY OF CURRENT IN SEPARATION OF CHARGED PARTICLES FROM PLASMA. P. E. Belensov, A. T. Kapin, A. A. Plyutto, and V. N. Ryzhkov. Zh. Tekhn. Fiz., 34: 2120-8(Dec. 1964). (In Russian)

Results are presented of experimental investigations of stability conditions in a plasma flowing from an orifice under the action of an electric field. Specifically, the case of the separation of the electronic component from plasma is described. Some data concerning the peculiarities of the separation of the ionic components are given. The plasma was generated by a stationary arc in vacuum, between a magnesium cathode and a circular anode, with an arc current range of 25 to 250 amp at voltages up to 15 v. Two orifices, the first of variable diameter (from 0.5 to 2.5 cm) and the second with a fixed diameter of 14 mm, could be put under a voltage difference up to 30 kv over a capacitor. The plasma concentration in the area of the first orifice at zero voltage was about (1 to 3) × 10^{11} particles per cm^3 with an electron temperature between 0.5 and 1.0 ev. The arrangement made it possible to maintain a quasi-stationary field condition at a slowly changing voltage difference. The different characteristics of plasma flow (the stationary flow, the transitory regime, and the unstable flow) were distinguished. The first displays the dependence of the current only on the fluctuation of the arc. The transitory regime is characterized by the possibility of relaxation oscillations, which may attenuate; the current does not depend appreciably on the inter-orifice voltage. With the unstable flow, modulation of the current between the orifices takes place within the whole range of applied inter-orifice voltages; the mean current value increases slowly with the voltage. The transition from one regime to another can be effected by a change of the arc current and by the initial voltage applied to orifices, i.e., initial field strength. Both possibilities were investigated and the results plotted. The dependencies of the form, period, and amplitude of the relaxation oscillations were studied in some detail. The relations are discussed in some detail and analytical expressions proposed. (ATD)

17135 CYCLOTRON INSTABILITY OF PLASMA WAVES IN NONUNIFORM PLASMA. Yu. N. Dnestrovskii (Moscow State Univ.). Zh. Tekhn. Fiz., 34: 2140-5(Dec. 1964). (In Russian)

It was shown previously that in theoretical analysis of plasmas in magnetic fields the stability of short plasma waves is strongly affected if one takes inhomogeneities of the magnetic field, due to plasma currents, into account. Particle drift, associated with field nonuniformity, leads to new types of instability and to modification of the regions of instabilities of known kinds. The instability of purely longitudinal waves propagating transversely to the external magnetic field in weakly inhomogeneous plasma is investigated theoretically. The considered waves are stable in a uniform field, but may, under certain conditions, become unstable in a nonuniform field. The treatment is limited to the simple case of plane geometry of the system and one-dimensional inhomogeneity, with specific attention to oscillations of the order of the ionic cyclotron frequency. Equations are written for the electric field potential, and the properties of the adduced $V_m^s(z,p)$ functions are discussed. The problem is analyzed by the method of a dispersion equation at the given point. It is shown that at sufficiently high plasma pressures and in the presence of steep density gradients very short waves (with a wavelength less than the Larmor radius and a frequency of the order of the Larmor frequency of the ions) become unstable. Finally, there are derived equations for the unstable wave increments under conditions of pronounced instability. (ATD)

17136 CONCERNING THE INSTABILITY OF IONIC CYCLOTRON WAVES IN PLASMA. K. N. Stepanov. Zh. Tekhn. Fiz., 34: 2146-52(Dec. 1964). (In Russian)

The excitation of longitudinal oscillations in a plasma in the field of an ionic cyclotron wave is investigated. If, under the action of the cyclotron-wave electric field, the plasma electrons and ions acquire a sufficiently high relative velocity, there may develop in the plasma a bunch instability, associated with excitation of longitudinal oscillations. It is shown that if the relative velocity u of the plasma electrons and ions is appreciably greater than the electron thermal velocity v_e, there should occur excitation of both modes of the high-frequency longitudinal oscillations of the plasma in a magnetic field. On the other hand, when $v_i \ll u \leq v_e$ (v_i is the thermal velocity of the ions), there is excited only the lower frequency mode and the oscillations propagate virtually normal to the magnetic field. After a general analysis, the case of excitation of oscillations of a plasma consisting primarily of a mixture of two kinds of ions and the case of excitation of oscillations in the presence of collisions (previously neglected on the assumption of high-temperature plasma) are considered. The instability increments are evaluated for different cases, and it is found that the increment in all the examined cases is substantially greater than the ionic cyclotron frequency; thus, under the postulated conditions the plasma is inherently unstable. The last is illustrated briefly by a numerical example. (ATD)

17137 METHOD OF SOLVING PROBLEMS INVOLVING MOTION OF PLASMA UNDER THE INFLUENCE OF AN EXTERNAL ELECTROMAGNETIC FIELD. G. E. London (Leningrad State Univ.). Zh. Tekhn. Fiz., 34: 2190-1(Dec. 1964). (In Russian)

H. Alfvén derived expressions relating the parameters of a homogeneous plasma in an external electromagnetic field with the parameters of an equivalent system: an electric circuit. A method is proposed for applying the Alfvén equations and approach to the case of an inhomogeneous plasma. The medium is divided into n regions in each of which the plasma may be regarded as homogeneous, and therefore, represented by an equivalent electric circuit. The interaction between the components of the regions is represented in the equivalent circuit by appropriate coupling impedances. A suitable circuit for n = 2 is shown. It is pointed out that the equivalent circuit method not only reduces the number (normally very large) of simultaneous equations that have to be solved, but makes it possible to computerize the procedure. Problems of the type susceptible of attack by the equivalent circuit procedure are encountered in MHD in investigating the flow of a conducting fluid in variable cross section channels under the influence of an external electromagnetic field, in designing MHD generators. (ATD)

17138 EXTRACTION OF HIGH-DENSITY ELECTRON BEAMS FROM SYNTHESIZED PLASMAS. A. L. Eichenbaum and H. Sobol (RCA Labs., Princeton, N. J.). p.179-84 of "Report on the Twenty-Third Annual Conference on

Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

Beam extraction from a plasma synthesized by providing electrons and ions at separate surfaces, each of which can be optimized to yield lower temperature operation, was studied. The results indicate that plasma cathodes using separate emitters can provide beam current densities at least comparable to those available from common-emitter cathodes. (D.C.W.)

17139 MULTIPLE PROBE MEASUREMENTS IN HIGH-FREQUENCY PLASMAS. Sol Aisenberg (Raytheon Co., Waltham, Mass.). p.200-8 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

A triple-probe method for accurate measurement of the retarding potential characteristics for probes in electrodeless high-frequency plasmas is described. (D.C.W.)

17140 LOW-ENERGY ELECTRON COLLISION CROSS SECTION IN CESIUM. R. K. Flavin and R. G. Meyerand, Jr. (United Aircraft Corp. Research Labs., East Hartford, Conn.). p.259-66 of "Report on the Twenty-Third Annual Conference on Physical Electronics." Cambridge, Mass., Massachusetts Inst. of Tech., 1963.

The collision frequency for momentum transfer of low-energy electrons with Cs atoms was determined from measurements of the microwave cyclotron resonance absorption and radiation spectra of a Cs plasma in a d-c magnetic field. The experiment was conducted to provide measurements of the collision frequency of electrons with Cs atoms at energies less than 0.1 ev. Measurements were made over a range of 0.05 to 0.06 ev, and the collision probability P (collisions cm^{-1} $(mm\ Hg)^{-1}$) measured at these energies increased from 1043 to 1125, respectively. (auth)

17141 RECENT DEVELOPMENTS IN PLASMA HEAT TRANSFER. Howard W. Emmons (Harvard Univ., Cambridge, Mass.). p.401-78 of "Modern Developments in Heat Transfer." New York, Academic Press, 1963.

Plasma dynamics is discussed, with emphasis on the continuum range in the temperature region from 6000 to 25000°K. The order of magnitude of heat transfer at a wall in contact with an argon plasma is shown. The division of heat transfer from a plasma between conduction and radiation and the effects of an axial magnetic field on radial heat transfer are discussed. Changes in properties of gases as their temperatures rise are shown using helium as an example. Thermodynamic and transport properties are considered, and equations given for calculating them. Studies of the properties of argon plasma are described and compared with theory. Data are presented in graphs. (M.C.G.)

17142 ELECTRICAL CONDUCTIVITY STUDIES OF THE COLD CATHODE PENNING OR P.I.G. DISCHARGE. D. K. Bose, D. C. Jain, B. D. Nagchaudhuri, and S. N. Sen Gupta (Saha Inst. of Nuclear Physics, Calcutta). p.169-73 of "Nuclear Physics and Solid State Physics Symposium." Bombay, Atomic Energy Establishment, 1964.

An experiment is described in which a plasma in a discharge tube with two cathodes and two anodes is directly probed using various types of solid probes. Measurements of electron temperature and ion density for fields of 1 and 2 kG are given. The procedure for evaluating the conductivity tensor from probe measurements is described, and numerical results are obtained for a 2 kG field. (M.J.T.)

17143 BEAM-PLASMA INTERACTION AT THE CYCLOTRON HARMONICS. P. L. Auer and S. Gruber (Sperry Rand Research Center, Sudbury, Mass.). 11p. (CONF-640606-17)

From American Physical Society Summer Meeting, Denver.

A monoenergetic electron beam of infinite extent in which all the particles drift along the uniform magnetic field at the same longitudinal speed and gyrate about the field lines with the same transverse speed is treated, using the quasi-static approximation. Space charge waves propagating at an arbitrary angle to the magnetic finite are sought. A two-fold infinity of wave modes connected with integral multiples of the electron cyclotron frequency is predicted. The interaction between the collisionless beam modes and a weak but warm plasma is stressed. It is found that the resistive contributions arising from Landau damping in the background plasma perturb the beam modes so that they become unstable. Finite growth rates are obtained even at frequencies significantly higher than the plasma frequency of either the beam or the background plasma. (D.C.W.)

17144 MAGNETOHYDRODYNAMIC WAVES IN A CYLINDRICAL PLASMA COUPLED TO AN EXTERIOR CIRCUIT. J. Peyraud (C.S.F.—C.E.P.E.C., Orsay, France). 8p. (CONF-640701-27). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The low-frequency waves propagated in a cylindrical plasma are studied in a general framework in order to apply the results to the development of an a-c MHD generator having no electrode in contact with the gas. The basic equations are given, and the power transfer on a circuit of finite length is calculated. (J.S.R.)

17145 TURBULENCE IN HYDRODYNAMICS AND PLASMA PHYSICS. S. F. Edwards (Manchester Univ., Eng. and Culham Labs., Culham, Abingdon, Berks, Eng.). 47p. (CONF-641008-1)

From Seminar on Plasma Physics, Trieste, Italy.

An analysis of turbulence in hydrodynamics is presented and extended to magnetohydrodynamic turbulence. General transport equations for plasmas are developed on the basis of the theory presented. (D.C.W.)

17146 AN INTEGRAL EQUATION APPROACH TO THE PLASMA SELF CONSISTENT FIELD PROBLEM. Peter M. Livingston (Univ. of Wisconsin, Madison). 33p. (CONF-641108-4).

From American Physical Society, New York.

The self consistent field problem of a "collisionless," fully ionized, single component plasma is treated by a Green's function technique. The latter describes the streaming motion of non-interacting electrons in a time dependent, homogeneous, applied electric field. A formal perturbation series solution to the Liouville equation, obtained by iteration, is then considered in the limit of large number and volume. For a problem time scale of the order of the inverse plasma frequency, only the terms in the perturbation series describing the collective interaction survive the limiting process; and therefore a time-reversible, hierarchy of integral equations is recovered for the various orders of distribution functions. The non-linear integral Vlassov equation follows from the first member of this hierarchy and a factorization assumption on the initial distribution function. An approximate solution to the Vlassov equation is developed in terms of the solutions to the linearized form of this equation. In these calculations, the Green's function was simplified by averaging it over a period of the external field. Finally, after defining the inverse dielectric function by the relation between the "dressed" and "free" electron number densities, a correction term of order e^2 to the usual linear theory result is found. It is expected that this correction will be found useful in subsequent studies of non-linear electrical behavior in plasma. (auth)

17147 LOCAL RESONANCES OF A PLASMA IN A MAGNETIC FIELD. Peter A. Sturrock (Ames Research Center, Moffett Field, Calif. and Stanford Univ., Calif.). 6p. (CONF-641108-5)

From American Physical Society, New York.

Resonances were observed with the Alouette topside sounder at frequencies for which plane waves in a homogeneous plasma have zero group velocity. An analysis of electrostatic resonances is presented, showing that the Alouette observations can be explained on the basis of the wave theory of a uniform plasma with nonzero temperature in a magnetic field. (D.C.W.)

17148 TIME-DEPENDENT AMBIPOLAR DIFFUSION. Z. Shimony and J. H. Cahn (Univ. of Illinois, Urbana). 10p. (CONF-641108-6)

From American Physical Society, New York.

Equations are derived for the charged particle density in a plasma expanding into a tube containing a gas. Some numerical results are included. (D.C.W.)

17149 A MECHANISM FOR INTERNAL CROWBARRING OF ROTATING PLASMAS. H. K. Forsen and A. W. Trivelpiece (Univ. of California, Berkeley). 9p. (CONF-641108-8)

From American Physical Society, New York.

A mechanism is proposed for the internal crowbarring of rotating plasmas observed after initial electron avalanche and voltage division. Experimental observations supporting the proposed mechanism are summarized. (D.C.W.)

17150 CONDUCTIVITY MEASUREMENTS CORROBORATING KADOMTSEV INTERACTION OBSERVATIONS. Donald A. McPherson and Alan J. Toepfer (Aerospace Corp., Los Angeles). 6p. (CONF-641108-9)

From American Physical Society, New York.

Recently the Kadomtsev current-convective interaction between a hydromagnetic wave and an electric current was observed. The dependence of the interaction upon all experimental parameters except the magnitude of conductivity was demonstrated. The conductivity has since been determined by measuring the electric field in the discharge by double electrostatic probes. In order to obtain consistent results, it was necessary to shield the electrodes of the probe from one another. The reason for this is not understood. The results are as follows: During the discharge with an initial gas filling of 75μ of helium, an electric field of 17 ± 2 volts/cm was measured. The current density of 10 ± 1 amp/(mm)^2 gives a conductivity of 59 ± 9 (ohm-cm)$^{-1}$ This is to be compared to a conductivity of 37 ± 14 (ohm-cm)$^{-1}$ required by the current-convective experiment. The value of 37 (ohm-cm)$^{-1}$ is higher than reported because the current density and radial conductivity gradient are larger than previously thought. (auth)

17151 THE PLASMA-BED: PERFORMANCE AND CAPABILITIES. W. M. Goldberger (Battelle Memorial Inst., Columbus, Ohio). New York, American Inst. of Chemical Engineers, 1964, Preprint 30c, 23p. $0.50. (CONF-641201-6)

From Symposium on Shipment of Radioactive Materials 57th Annual Meeting, Boston.

Problems associated with the use of plasmas to react solids are discussed. Experiments were made on the reduction of tricalcium phosphate to elemental phosphorus, using an Ar plasma jet and W or graphite electrodes. The desirability of introducing solid reactants directly into the arc formation region of the plasma-generating device, rather than into a high-velocity plasma jet downstream was indicated. This open, high-intensity arc is best for conducting highly endothermic chemical changes within solids. The technical feasibility of using ultrahigh temperatures in conjunction with fluidized-solid systems to promote chemical reactions is thus demonstrated. The use of electrically conductive fluidized particles as one electrode of a plasma-generating device was also shown. (M.J.T.)

17152 ON THE STABILITY OF STATIONARY MHD EQUILIBRIA WITH ANISOTROPIC PRESSURE. Gerhard Berge (Univ. of Bergen, Norway). 12). (CONF-783-1)

From Norwegian Physical Society Annual Meeting, Bergen, Norway, June 1963.

The theory of Frieman and Rotenberg is generalized to describe systems with anisotropic pressure. The Chew-Goldberger-Low approximation is used. Sufficient stability conditions are obtained in analogy with the previous results. The self adjointness of the force operator is proved using the conservation of energy of the system, for the cases both of an infinitely-conducting rigid wall surrounding the plasma and of a plasma surrounded by a vacuum magnetic field. (auth)

17153 FUSION REACTOR. Siegfried Hansen and Giusto Fonda Bonardi (to Litton Systems, Inc.). U. S. Patent 3,155,592. Nov. 3, 1964. Filed Aug. 19, 1960.

A fusion power reactor in which relatively cold plasma particles are fused is described. The reactor employs a mixture of deuterium and tritium as fuel and includes two or more plasma accelerators capable of accelerating two or more toroid-shaped plasma masses to collide within a predetermined collision area with a force sufficient to cause fusion. A relatively small inward directed velocity imparted to the plasma by the accelerating apparatus is sufficient to converge the plasma after leaving the accelerating apparatus to a small mass having a high frontal area density without the application of any external force. Means are provided for transferring into useful power the energy produced when either two deuterium nuclei or a deuterium nuclei and a tritium nuclei collide. (A.G.W.)

17154 APPARATUS FOR CONFINING AND HEATING A PLASMA. Bo Peter Lehnert and Bjoern Karl Johan Bonnevier. U. S. Patent 3,155,594. Nov. 3, 1964. Priority date June 12, 1959, Sweden.

The apparatus described consists of an annular conductor for generating a magnetic field adapted to confine plasma within a reaction volume defined by two substantially toroidal confining members each coinciding with a field line generated in the magnetic field. Means extend inward from the annular conductor for supporting it and for supplying the electric current necessary for the creation of the magnetic field. Means for generating an electric field perpendicular to the magnetic field include inner and outer electrodes, each located in one of the toroidal members. The maximum outer electrode diameter is at least twice its minimum diameter. (A.G.W.)

17155 HIGH TEMPERATURE GAS CONFINEMENT ARRANGEMENT. Vernal Josephson (to Space Technology Labs., Inc.). U. S. Patent 3,156,621. Nov. 10, 1964. Filed Dec. 14, 1960.

An apparatus for the stable containment of a plasma by the combination of d-c and r-f magnetic fields is patented. A high-power klystron has a resonant catcher cavity concentric with a plasma-containing torus. A d-c magnetic drive on the outer surface of the torus is energized to initiate a dense pinching current in the plasma. A power klystron is caused to oscillate during the flow of the high pinched current in the plasma. The standing wave modes in the resonant cavity of the klystron produce r-f magnetic fields that surround the plasma in a direction orthogonal with respect to the d-c magnetic fields, both fields together effecting a stable containment of the pinched plasma. The windings of the d-c magnetic field are arranged outside the torus and therefore will not interfere with the r-f fields. (A.G.W.)

Shielding

17156 (EUR-2197.d) ABSCHIRMUNGSEXPERIMENTE AM FORSCHUNGSREAKTOR GEESTHACHT. JAHRESBERICHT 1963. (Shielding Experiments at the Reactor Station Geesthacht. Annual Report, 1963). E. Bagge (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). Dec. 1964. 208p. Dep.(mn).

Measurements are reported on 11 different shielding arrangements, as are improvements in experimental techniques. Apart from the measurements, tables were compiled giving a first rough view of the shielding properties of several different material combinations. The optimal volume ratio of metal to hydrogen-containing components was found. Here the reactor FRG-2 was available for experiments with a reactor power of up to 200 kw. As the activity of the fuel elements was still relatively low, the spectrum of the prompt gamma radiation was measured with a three-crystal pair spectrometer. For further shielding research the radiation field of FRG-2 was measured in water. The gamma-radiation was additionally measured with fluorescence-glass-dosimeters, and the fast neutron flux in water using the $^{16}O(n,p)^{16}N$ reaction. The very different

decrease of the neutron and gamma intensity in water was utilized to find evidence of the contribution of the secondary gamma-rays from iron to the total dose rate. A proton-recoil spectrometer and a pair spectrometer used for gamma-measurements were built. Semiconductor neutron spectrometers were developed. The capture gamma radiation was calculated. Some shielding setups have been calculated with a program combining the removal neutrons and core gamma-radiation program as well as RASH and GASH. Evaluations are presented. (auth)

17157 (ORNL-3714(Vol.I)(p.43-67)) REACTOR SHIELDING. (Oak Ridge National Lab., Tenn.).

Research summaries are presented on neutron spectra in water shielding, calibration of the Bulk Shielding Reactor I (BSR-I), gamma spectra from stainless steel-clad BSR-II, experimental verification for shielding calculations, statistical estimation of neutron distribution in water, neutron reflection from concrete, model of air-ground fission neutron distributions, Tower Shielding Facility studies, neutron transmission through LiH, and neutron scattering from LiH, graphite, Al, and steel. References to publications in which the research is described are included. (J.R.D.)

17158 (ORNL-3714(Vol.I)(p.68-9)) RADIATION SHIELDING INFORMATION CENTER. (Oak Ridge National Lab., Tenn.).

Activities at the Radiation Shielding Information Center (RSIC) are summarized. The RSIC information retrieval system operation is reported along with work on collection of shielding computer codes. (J.R.D.)

17159 (ORNL-3714(Vol.II)(p.97-118)) THEORETICAL STUDIES OF HIGH-ENERGY RADIATION SHIELDING. (Oak Ridge National Lab., Tenn.).

Research is summarized on nucleon transport codes, tissue dose factors for nucleons at less than 400 Mev, calculations on secondary particle factors in space vehicle shielding, approximations used in space vehicle shielding, estimation of solar-flare proton doses, intranuclear cascade calculations for incident particles at 25 to 350 Mev and 25 Mev to 2 Bev, rapid computation of charged-particle energy losses, electron energy deposition on astronomical LiF optical systems, meson source shielding, solutions of nucleon-meson cascade equations, calculations of shielding for 45-Bev electron accelerators, center-of-mass spectra statistical models for N-N and π-N collisions, calculations for nucleon-nucleus and pion-nucleus collisions at 2 to 10 Bev, CDC-1604 computer pair production cross-sections program, output fluctuations in intranuclear cascade computations, bremsstrahlung cross sections for low-energy electrons, and solar flare attenuation by Al shielding. References to publications in which the research is described are included. (J.R.D.)

17160 (ORNL-3714(Vol.II)(p.119-33)) EXPERIMENTAL STUDIES FOR HIGH-ENERGY RADIATION SHIELDING. (Oak Ridge National Lab., Tenn.).

Research is summarized on proton beam distributions and intensity at the Harvard synchrocyclotron, gamma spectra from proton reactions with Be, C, Co, Al, O, and Bi at 160 Mev, cross sections for proton production in reactions of 160-Mev protons with nuclei, neutron and proton spectra from targets bombarded by protons at 160 to 450 Mev, comparison of calculated and experimental spectra from proton reactions with nuclei at 50 to 160 Mev, measurement of proton-induced gamma spectra at ORIC, energy deposition in water-filled spherical phantoms by secondaries from high-energy neutrons and protons, and cross sections for $^{9}Be(\alpha,n)$ reactions at 6 to 10 Mev. References to publications in which the research is described are included. (J.R.D.)

17161 (ORNL-P-786) THE VALIDITY OF THE STRAIGHTAHEAD APPROXIMATION IN SPACE VEHICLE SHIELDING STUDIES. R. G. Alsmiller, Jr., D. C. Irving, W. E. Kinney, and H. S. Moran (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 13p. (CONF-720-7). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Many of the shielding studies for manned space vehicles have been carried out in what is usually called the straight-ahead approximation. This approximation greatly simplifies the computation, but its use necessarily introduces inaccuracies. To test the validity of the approximation, calculations were carried out and compared with results obtained with the angular distribution of the secondary particles properly taken into account. (C.E.S.)

17162 (ORNL-P-801) THE SECONDARY PARTICLE CONTRIBUTION TO THE DOSE FROM MONOENERGETIC PROTON BEAMS AND THE VALIDITY OF CURRENT-TO-DOSE CONVERSION FACTORS. D. C. Irving, R. G. Alsmiller, Jr., W. E. Kinney, and H. S. Moran (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 9p. (CONF-720-9). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The validity of the current-to-dose conversion factors was investigated for the case of monoenergetic protons isotropically incident on an infinite slab shield followed by a slab of tissue. The calculations were performed by the Monte Carlo method using the NTC code. Carbon, aluminum, and copper were considered as shield materials in order to investigate any variation in atomic mass or number of the shield. Shield thicknesses of 10 and 30 g/cm^2 were considered. In all calculations a 30-cm-thick slab of tissue followed the shield. Monoenergetic protons of energy 100 or 400 Mev were taken to be incident on the shield with the angular distribution of a current due to an isotropic flux. (C.E.S.)

17163 THE DEPENDENCE OF RADIATION DENSITY VARIATIONS IN REACTOR VESSELS ON THE COMPOSITION OF IRON–WATER THERMAL SHIELDING. K. K. Popkov and S. M. Rubanov. At. Energ. (USSR), 18: 70-1 (Jan. 1965). (In Russian)

Radiation density variations in a primary shielding composition consisting of 25 cm iron–water mixture, 9 cm iron, and 30 cm water were investigated. A spatial energy distribution of neutron fluxes in 7 group plane geometry schemes was studied with iron concentrations of 0, 10, 20, 40, 50, 60, 70, 80, 90, and 100%. The curves of radiation density variations across the iron layer in the primary shielding indicated the minimum variation with 55 to 60% iron. (R.V.J.)

17164 SELF-ABSORPTION IN SPHERES AND CYLINDERS OF RADIOACTIVE MATERIAL. Ernesto Trucco (Argonne National Lab., Ill.). Bull. Math. Biophys., 26: 303-25(Dec. 1964).

According to the reciprocity law, the total dose absorbed in a specimen irradiated by a point source can be inferred from the reciprocal situation, where the absorber is replaced by a source of the same shape and the radiation is measured at the position of the original point source. For a spherical source of homogeneous radioactive material with absorption coefficient μ_1, the intensity of radiation (or flux) at a point P is calculated, as well as the intensity which would be found at the same point if μ_1 were zero. The ratio between these two quantities is denoted by k. It is assumed that absorption follows the simple exponential law. Self-absorption can also be characterized by the number v, which is defined as the ratio between the total radiation current flowing through the surface of the source and the total current obtained if there were no absorption. For a homogeneous spherical source in a nonabsorbing medium, it is shown that the quantity k becomes equal to v if the distance between the point P and the center of the sphere is sufficiently large. This fact was used by Sinclair in estimating an absorption coefficient from his experimental results. An expression is also derived for the self-absorption ratio of a cylindrical source. In the limiting case of an infinitely long cylinder, the result coincides with an equation previously found by Kushneriuk. (auth)

17165 MEASUREMENTS OF GAMMA BACKSCATTERING ON CONCRETE WALLS. V. Ito. Genshiryoku Kogyo, No. 3, 22-5(1964). (In Japanese)

Backscattering of ^{137}Cs gamma rays from concrete walls was studied to obtain shielding data. A 1-μC ^{137}Cs source (5 mm dia) was placed in the center of a 20- by 20-cm diffuser whose thickness was more than twice the mean free path of the radiation. Except with lead, diffusion increased with increasing specific gravity. The diffusion spectrum of lead was the same in the absence of diffuser if the characteristic peak value of lead was neglected. For studying gamma backscatter screening, a 50- by 50-cm diffuser of 10-cm-thick concrete was used, with a 500- by 500- by 1-mm lead sheet. Both the source-diffuser and the diffuser-measuring instrument distances were 1 meter. The diffuser was at a 45° angle to the radiation. Results showed that the angle is very important in screening with lead. Measured gamma backscatter values were close to theoretical. (IIC-M.G.)

17166 ASYMPTOTIC EXPANSION OF THE INTENSITY OF THE SMALL-ANGLE X-RAY SCATTERING FROM CYLINDERS OF ARBITRARY CROSS SECTION. Paul W. Schmidt (Univ. of Missouri, Columbia). J. Math. Phys. (N. Y.), 6: 424-31(Mar. 1965).

From a previously developed expression for the intensity of the small-angle x-ray scattering from randomly oriented right cylinders of arbitrary cross section and with uniform electron density, an asymptotic expansion is developed which can be used to approximate the scattered intensity at relatively large angles of the small-angle region. The asymptotic expansion is useful for numerical calculations at these large angles, where calculations by the usual techniques of numerical integration and series expansion are most difficult. The terms in the asymptotic expansion are found to be determined by the behavior of the characteristic function $\beta(r)$ of the cross section at certain values of r. The general asymptotic expansion is used to calculate asymptotic expressions for the scattering from right circular cylinders and rectangular parallelepipeds. (auth)

17167 STUDY ON SHIELDING OF INDUSTRIAL RADIOGRAPHICAL X-RAY. Takashi Maruyama (National Inst. of Radiological Sciences, Chiba, Japan). J. N. D. I. (Japan), 13: 197-202(July-Aug. 1964). (In Japanese)

Recently, it has been widely desired to develop a useful method of indicating the quality of industrial radiographic x rays from the stand point of radiological protection. Study on this problem was performed, employing two kinds of x-ray generators (rectified and non-rectified). The results led to the conclusion that as the x rays, attenuated by iron absorbers of suitable thickness so as to be below 1 mR/mamp min at (FCD) 1 m, were confirmed to be of monochromatic energy, the dose rate D_0 estimated by extrapolation from the part of the attenuation curves should be preferably used as an indicator of the quality of the x rays. That is to say, the absorption coefficient, the most important factor for the x-ray shielding, could be easily obtained from the value of D_0. (auth)

17168 A METHOD FOR THE NUMERICAL INTEGRATION OF THE PHOTON TRANSPORT EQUATION IN SLAB GEOMETRY. Iwao Kataoka and Kiyoshi Takeuchi (Ship Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 30-8(Jan. 1965).

A procedure for the direct numerical integration of the transport equation in slab geometry is introduced. The angular flux is expressed as a series of Legendre polynomials. The iteration process is utilized for the spatial integration of the transport equation. Prior to applying this method both to neutrons and to photons, a series of studies on the photon penetration problem was performed to assess its validity. The first code, the EOS-1, was prepared for the NEAC 2206 computer to perform the work and also to solve some practical problems of not very large scale. A comparison of energy buildup factors obtained by the EOS-1 code with those from the moments method and from the Monte Carlo method indicated that the method presented provides a correct treatment of the attenuation of radiations in a slab. The results also agreed with the energy spectra from the moments method, with the energy spectrum measured in the Bulk Shielding Reactor and with the energy-angular flux distributions obtained with ^{60}Co and ^{137}Cs sources behind iron and aluminum plates, both with respect to spectrum pattern and to absolute values. (auth)

17169 FUNDAMENTAL RESEARCH ON HIGH-ENERGY RADIATION SHIELDING. Hiroji Noda (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 387-94(July 1964). (In Japanese)

An electron beam and x rays of energy 10–29 Mev from a betatron for medical were used for an experiment for shielding purposes. The practical range of electrons in various materials was measured. The practical range generally agreed with calculations that included the effect of multiple scattering of electrons in the energy range 10–20 Mev, but at energies above 25 Mev a large difference between the experiment and calculations was observed. The intensity and angular distribution produced during the stopping of the electrons in various materials were measured to investigate the functions of atomic number and energy. The results show that the bremsstrahlung intensity in the forward direction is generally independent of the atomic number and of the energy of electrons, and the intensity in the 90° direction is related to atomic number in exponential function. When the water phantom is irradiated by the electron beam, the energy distribution of bremsstrahlung in each direction for the phantom is obtained by attenuation measurements in a Pb absorber. The energy build-up factors in Al, Fe, and Pb are obtained by attenuation measurements of the energy of 29-Mev x rays. (auth)

17170 SHIELDING FOR HIGH-ENERGY ELECTRON ACCELERATOR INSTALLATIONS. Recommendations of the National Committee on Radiation Protection and Measurements. NCRP Report No. 31. (National Bureau of Standards, Washington, D. C.). National Bureau of Standards Handbook 97. July 1, 1964. 74p. $0.30(GPO).

Presently available data needed and the procedure to be followed for the calculation of shielding for high-energy, high-intensity electron accelerators are summarized. Consideration is given to electrons from 0.5 to 100 Mev and output power to 100 kw. General considerations for determination of shielding requirements are outlined. Beam characteristics are described for the primary electrons, and yields for bremsstrahlung, neutrons produced by electrons or bremsstrahlung, and residual radioactivity are discussed. Units and survey and monitoring instruments for measurement of the various radiations are covered. Radiation interactions with matter and the consequent necessary shielding are discussed for electrons, monoenergetic and bremsstrahlung photons, and neutrons, for various energies and target materials. Radiation damage to electric safety devices and fire hazards in irradiated material are briefly considered. 54 references. (M.J.T.)

17171 RADIATION DOSE RESULTING FROM A 1.25 Mev PLANE SOURCE BEHIND VARIOUS ARRANGEMENTS OF DISK AND RECTANGULAR BARRIERS. Dominic J. Raso and Stanley Woolf (Technical Operations Research, Burlington, Mass.). 20p. (CONF-654-38)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Monte-Carlo calculations were made for the doses from scattered gamma rays at various points behind barriers. Two geometries were considered: one horizontal and one vertical barrier of various length-to-width ratios, and two barriers perpendicular to one another. The results are compared with calculations of structure shielding against fallout radiation. (D.L.C.)

17172 ANALYTICAL FORMULATION OF PROTON DOSE RATES BEHIND SPHERICAL MULTILAYER SHIELDS. F. R. Nakache (United Nuclear Corp., White Plains, N. Y.). 22p. (CONF-720-18)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

In order to develop spherical minimum-weight proton shields, analytical expressions were developed for calculating primary proton dose rates such as average body doses, skin doses, depth doses, and local doses. For these calculations, the shield layers and the crewman model must be spherical, and the incident proton spectra must have an isotropic angular distribution. (D.L.C.)

17173 A SPACE RADIATION SHIELDING CODE FOR REALISTIC VEHICLE GEOMETRIES. K. M. Simpson, C. W. Hill, and C. C. Douglass (Lockheed-Georgia Co., Marietta). 13p. (CONF-720-14)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

A computer code system is described which estimates primary proton and associated secondary dose at points within complex geometric configurations of materials. The manipulation of geometric data in this system is considered in some detail. The validity of the dose calculations is checked by sample calculations for Al, Fe, and H_2O. Estimated doses from solar flare are given for various detector locations in an 8-man interplanetary module with 7.6- and 1.0-inch polyethylene shield. (D.L.C.)

REACTOR TECHNOLOGY

General

17174 (ANL-6900(p.232-303)) REACTOR SAFETY. (Argonne National Lab., Ill.).

The experimental program to determine rates of reaction of molten reactor fuel and cladding metals with water is continuing. In general, it has been found necessary to study the reaction of each metal of interest by several methods. Some of these techniques are designed to study the reactions under isothermal conditions. One such method is the levitation experiment which has been used to study the reaction of steam with pure Al (see ANL-6648, p.196), with an Al-U-Ni-Fe alloy (SL-1 composition), and with commercial Al alloy 6061 which contains 1.0 wt % Mg as the principal alloying agent. In this method, a sample pellet is simultaneously heated and supported in flowing steam by a radiofrequency field within a levitation-induction coil. In the experiment, molten specimens were exposed to steam at a controlled temperature for a period of time ranging from 5 to 100 min. The extent of reaction was determined by selective dissolution of Al, leaving the oxide intact. At 1200 and 1300°C, the reaction could be best described by a cubic rate law for pure Al and for both of the alloys studied. The same cubic rate equation also described the reaction of the Al-U-Ni-Fe alloy at 1400, 1500, and 1600°C, although the experimental results at 1600°C were about 50% higher than those predicted by the cubic rate law. The results with pure Al at 1400, 1500, and 1600°C were interpreted in terms of an initial cubic reaction followed by a linear reaction which commenced after 2.3 mg Al/sq cm reaction had occurred. At 1400, 1500, and 1600°C, values of the extent of reaction of 6061 Al alloy were scattered and were generally greater than those of pure Al. The results were interpreted on the basis that the protective oxide film formed on the surface of the alloy is disrupted by vaporizing Mg during a portion of the reaction and that the rate of reaction during this period is thereby increased. Another method of studying metal-water reactions under isothermal conditions is one in which steam was passed over inductively heated specimens, and the quantity of reaction was determined continuously by measurements of the volume of H_2 produced. Significant reaction occurred at 1100°C where the rate could be described approximately by a parabolic law. The reaction rate at 1300°C was found to depend on the rate at which the sample was heated. A third method of studying metal-water reactions under isothermal conditions is under development. A brief study was completed of the thermal decomposition of steam over inductively heated surfaces. The rate of production of knallgas ($2H_2 + O_2$) over heated Pt and Ir samples was determined as a function of specimen temperature and steam flow rate. The apparent activation energy of the decomposition reaction was 32 to 40 kcal/mole, which is similar to the apparent activation energy for the equilibrium dissociation of steam, 41 kcal/mole. Some of the experimental techniques used to study metal-water reactions were designed to observe the reactions with small particles under nonisothermal conditions. One of these methods uses the energy contained in the light beam from a ruby laser to heat single particles of metal in a water environment. The experiment is designed not only to study the chemical reaction of particles with water, but also to study the transient energy exchange and associated hydrodynamic effects. Results with a 360-μ-dia. Al sphere showed that the extent of metal-water reaction varied between 6 and 12% and was independent of the laser energy, while with a 620-μ-dia Zr sphere, there was about 30% reaction which was also independent of laser energy. The result with Zr has been predicted from previous studies by the condenser discharge method for fully melted particles. Another method used to study water reactions with finely dispersed metal is the condenser discharge experiment. A recent attempt was made with Al wires encased in a thin-walled Ni tube. Composite Ni-Al wires of this kind were heated and dispersed in water by a surge current from a bank of condensers. The extent of reaction was determined by analysis of the quantity of H_2 generated. The results indicated negligible reaction in room temperature water regardless of overpressure but reaction of 20 and 60% in 242 and 335°C water in runs in which the wires were heated to temperatures of about 1500 and 2000°C. The third general method of studying metal-water reactions involves nuclear heating of typical reactor fuel materials in TREAT. In these studies, small fuel specimens were submerged in water in high-pressure autoclaves which were then placed at the center of TREAT and subjected to severe nuclear transients. The extent of reaction for Zircaloy-clad specimens reached a value of 80% for a maximum fission energy input of 770 cal/g of UO_2 core, while a stainless steel-clad specimen reached 35.5% reaction for a maximum fission energy input of 690 cal/g of UO_2 core. The residue in the more energetic runs had the form of one larger particle and a considerable quantity of powdered material. Pressure traces indicated that no explosive pressure rises occurred. Several experiments in TREAT with preirradiated fuel material were completed. Studies of transient heat transfer were initiated to provide further insight into the mechanism of reactor meltdown accidents. Initial efforts were calculational in nature and were directed toward obtaining an understanding of the violent pressure surge produced during the meltdown of the SPERT-ID reactor core. Another experimental program, nearly completed, involves studies of the kinetics of oxidation and ignition of reactor metals, such as U and Pu. Further characterization of the ignition behavior of a U–30 at.% Pu–6 at.% Fe alloy, which is being considered for zero power experiments, indicated that the ignition behavior is sensitive to fabrication procedure and aging. Study of ignition behavior of a U–18 at.% Pu alloy indicates that the addition of 14 at.% Fe offers no advantage. The ternary alloy U–20 at.% Pu–6 at.% Mo shows nearly as much resistance to ignition as unalloyed U. A U–10 wt % Mo alloy is frequently considered for use as core material in nuclear assemblies. Rising-temperature oxidation experiments showed that no ignitions occurred with 1-cm cubes of the alloy up to the limit of the thermobalance apparatus, i.e., up to about 800°C. Because of the practical interest in this alloy and the relative inertness to oxidation exhibited in the rising-temperature experiments, a series of isothermal experiments were performed. In general, oxidation rates were at least an order of magnitude lower than those of unalloyed U. Studies of the thermal conductivity of U and Zr powders were completed. Predicted ignition temperatures were somewhat higher or lower than the experimentally determined ignition temperatures, depending on whether first or second stage U oxidation kinetics were used. Studies were continued of the U_3O_8-Al thermite reaction. Experiments demonstrated that compacts fabricated from –400 mesh powders were more reactive than compacts fabricated from coarser powders, as measured by peak temperatures reached by the samples upon being plunged into a preheated furnace. Previously sintered specimens also achieved higher temperatures than those not so treated, with heating rates measured in thousands of degrees per second by an electronic two-color pyrometer. Concentrations studied were primarily at the 75–85 wt % U_3O_8 levels, where the potential for violent reactions was demonstrated. Preliminary experiments have now begun with cermets having U_3O_8 concentrations (40 wt %) in the range of fuel material. Tests in this composition range indicated that self-heating rates are limited to a few hundred degrees per second. (auth)

17175 (ANL-6965) REACTOR DEVELOPMENT PROGRAM. Progress Report, October 1964. (Argonne Na-

tional Lab., Ill.). Nov. 15, 1964. Contract W-31-109-eng-38. 107p. Dep.; $4.00(CFSTI).

Summaries are presented of developments in liquid metal cooled reactors, general reactor technology, advanced systems, and nuclear safety. Separate abstracts were prepared for the 4 topics. (J.R.D.)

For abstracts of individual sections see: 17176, 17177, 17178, and 17359.

17176 (ANL-6965(p.1-41)) LIQUID-METAL-COOLED REACTORS. (Argonne National Lab., Ill.).

A comparison between results of Doppler measurements for ½-in.- and 1-in.-dia natural UO_2 elements at 500 and 1100°K showed a 11% decrease in Doppler coefficient for the larger element that was attributed to self-shielding. Recalibration of safety-control rods in ZPR-IV is reported. Measurements were made of Na void coefficients using various material arrangements within the core drawers. Data are included on core and blanket compositions in ZPR-IV assembly 3 along with data on Na void coefficient in the center of assembly 3 and on radial dependence of Na void coefficient near the interface of this assembly. Studies of homogeneous W–Re-diluted and ^{235}U-fueled reactor cores were completed. Data are included on physical properties of ZPR-IX assembly No. 4B, central reactivity worths for several elements including H_2 and H_2–B mixtures. Results of spatially dependent Rossi-alpha measurements made at various locations in ZPR-IX are being analyzed. Research devoted to development of metallic fuel and jacket materials is reported along with results of fast reactor fuel irradiation testing. Work is reported on the compaction of powdered material and the radiation testing of materials for radiator-type elements. Research on fabrication and jacketing methods for zero-power reactor elements is reviewed. In fast reactor fuel reprocessing, the skull reclamation process, materials and equipment evaluation, advanced processes, consolidation of fission product wastes, removal of TV-20 cladding, and use of eddy-current induction probes were further developed. Studies of cover-gas impurity effects in Na coolants are reported along with development work on activation analysis for O_2 in liquid-metal coolants. Work related to EBR-II concerns operation, investigation of sticking control rod and oscillator drive mechanisms, reactor physics, testing of systems and components, development of the fuel cycle facility, and fuel burnup determinations. Activities associated with FARET were concerned mostly with engineering. Studies of FARET behavior during scram were conducted. Design work on the FARET vessel is reported along with work on cell components such as containment, lights, cell shielding windows, and cell penetration arrangements. (J.R.D.)

17177 (ANL-6965(p.42-83)) GENERAL REACTOR TECHNOLOGY. (Argonne National Lab., Ill.).

Neutron spectra were measured at the center of ZPR-IV assembly No. 2 and at JUGGERNAUT beam hole No. 4 using a solid state detector. Gamma radiation appears to be the main background contributor. An excursion alarm and recorder was designed and installed in the EBR-II control room. Measurements made in a high-conversion critical experiment are discussed, and it is noted that a report on the completed phases of this program is being prepared. Calculations are presented to show that the calculated worth for a bank of rods is greater than the measured value. Other calculations concerned with improved escape probability estimates, resonance interference effects estimates, and total cross sections for neutron scattering resonances. An improved method of measuring resolution losses in radiation-counting equipment is reported along with an analytical method for optimizing reflector-located control thickness. Work on development of high-temperature materials was directed toward thermal properties of fuel-bearing ceramic materials. Cladding materials for Th–Pu–U alloys were tested for diffusion at high temperatures, and data are included on the interdiffusion of stainless steel with these materials. Elastic properties of Ti–V alloys were studied along with structural metal polarization in liquid metals. Developments in remote-control equipment is discussed along with liquid metal technology development. Heat engineering experiments are described, and data on the transient behavior of steam voids in reactor coolants are included. Developments in fluidization and volatility separation processes are discussed along with preparation of fuel-bearing carbides. Studies on the chemistry of liquid metals are reported, and developments in the Pu recycle program are discussed. (J.R.D.)

17178 (ANL-6965(p.91-8)) NUCLEAR SAFETY. (Argonne National Lab., Ill.).

In thermal reactor safety studies, experiments to determine the effects of pressure on Al–water reactions are described. Experiments in TREAT to investigate the safety problems associated with the behavior of unclad UO_2 under conditions simulating a power excursions are also described. An experimental investigation of transient heat transfer in liquid Na is discussed in which water is used as a stand-in for Na. Plans for an investigation of transient pressure phenomena in vaporizing liquid metal coolants are outlined. Critical constants were estimated for UO_2 for use in calculations of accidents in which the core material reaches excessively high temperatures. Design and development of the large TREAT loop is discussed. (J.R.D.)

17179 (BNL-841(p.1-17)) REACTOR PHYSICS DIVISION. J. Chernick and H. Kouts (Brookhaven National Lab., Upton, N. Y.).

Research was devoted to problems in multivelocity transport theory for thermal neutrons, lattice physics, reactor kinetics, fluid flow, and general reactor studies. Analysis of the power map data obtained from the HFBR K core mockup was completed. Special fuel elements were designed, fabricated, and are ready for testing in the Beam Experiment Test Assembly. Measurements of buckling and reflector savings were begun on the clean water lattices. The disadvantage factor for low enrichment uranium rod lattices was remeasured in an attempt to obtain more accurate values. The Van de Graaff accelerator and console were installed at its new berth. Several modifications and design improvements of the associated electronic equipment were carried out resulting in a signal-to-background ratio of 10^6 to 1. An analysis of liquid metal piston MHD systems showed that potassium is the best working fluid. The specific conductance of fused $PbBr_2$ was determined for temperatures between 373 and 918°C. A fuel cycle analysis code for fast breeder reactors was completed and final modifications are being made prior to starting production runs. The development of the Settled Bed Reactor is summarized. (N.W.R.)

17180 (BNL-841(p.102-3)) ENGINEERING DIVISION. T. V. Sheehan (Brookhaven National Lab., Upton, N. Y.).

On the HFBR project, all face plates for the biological shield are completed. The cooling tower is completed and is being used by the BGRR. Design work for the NaK Heat Transfer Loop was completed. All major items of the Boiling Potassium Heat Transfer Loop were installed. The fabrication and testing of components for the Chemonuclear Loop are continuing. The natural circulation boiling sodium loop was shutdown for rebuilding after a 1000-hr run. The pumped boiling sodium loop is being fabricated. Fabrication of the equipment for the UO_2–ThO_2 lattice experiment and the low mass critical assembly was finished. Work on the BNL standard irradiation sources is continuing. (N.W.R.)

17181 (WCAP-3728) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. SUMMARY REPORT OF DESCRIPTIONS OF TOPICAL REPORTS. (Westinghouse Electric Corp., Pittsburgh, Pa., Atomic Power Div.). Sept. 1964. Contract AT(30-1)-3064. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Work is described on reactor physics; core mechanical, thermal, and hydraulic characteristics; chemical shim development; and aspects of chemical shim plant control. Results of the work conducted have been described in various

topical reports. This document collects brief descriptions of each of these. In general, in the reactor physics area, methods to calculate the various nuclear parameters of large, chemically shimmed closed-cycle water reactor cores were developed. These methods were utilized to establish certain characteristics such as the effect of chemical shim on moderator coefficients, power distribution variations resulting from the cycling of fuel, and, in a preliminary fashion, effects of control rod motions. Work in the mechanical, thermal, and hydraulic area covered the development of an advanced fuel assembly and control rod train components. Tests were conducted of a full scale prototype fuel assembly at typical reactor conditions of temperature, pressure and flow. Measurements were made of flow mixing between prototype fuel assemblies and support full-length-element burnout tests were run. In the chemical shim area, basic properties of boric acid solutions, such as vapor pressure volatility and solubility were determined. Heat transfer corrosion tests of mocked-up fuel assemblies and radiotracer corrosion tests of fuel cladding to determine the significant interactions between the materials and the coolant were performed. To obtain in-pile data and experience with chemical shim solutions, prototype test sections were irradiated for five cycles in an in-pile loop in the Westinghouse Test Reactor. Work conducted on the aspects of chemical shim plant control was mainly concerned with the development of methods of calculation to adequately describe the transient behavior of conceptual plant systems in response to various operational demands. (auth)

17182 REDUCED CAPTURE GAMMA-RADIATION FROM BORON-SCREENED REACTOR CONSTRUCTION MATERIALS. B. F. Gromov, D. V. Pankratov, M. A. Solodyankin, and M. M. Sokolov. At. Energ. (USSR), 18: 69-70(Jan. 1965). (In Russian)

The spatial and energy distribution of γ rays in steel screens and reactor vessels was measured by the 18-group method and a P_2 approximation using a computer. The curves of capture γ-ray density across the thickness of steel and boron steel were analyzed. The attenuation dose of γ emission measured as a function of the "optical" thickness between the source and detector was in agreement with experimental data. (R.V.J.)

17183 LIGHT METALS AND NUCLEAR METALLURGY. J. Herenguel (Etudes et Fabrications Nucleaires de la Societe Trefimetaux, [Antony, France]). Energie Nucl., 6: 409-16(Nov. 1964). (In French)

The suitability of Al, Be, Mg, and alloys thereof for nuclear applications is reviewed, together with applications and technology of these metals and alloys. (D.C.W.)

17184 RARE EARTHS IN REACTOR TECHNOLOGY. W. Mialki (Technische Universität, Berlin). Metall, 19: 16-21(Jan. 1965). (In German)

The suitability of the rare earths and their alloys for various applications in reactors is discussed. (D.C.W.)

17185 EXPERIMENTS ON NOISE AS AN AID TO REACTOR AND PLANT OPERATION. L. C. James (Dounrey Experimental Reactor Establishment, Caithness, Scot.). Nucl. Eng., 10: 18-22(Jan. 1965)

Some research on the detection of temperature, heat flux, liquid level and pressure changes and on leak detection using associated acoustic noise is reviewed. (D.C.W.)

17186 MONITORING REACTOR DYNAMICS ON-LINE. J. F. Hogg (Atomic Energy Establishment, Winfrith, Dorset, Eng.). Nucl. Eng., 10: 23-5(Jan. 1965).

Some possible methods for obtaining the dynamics of a reactor system are briefly discussed; and a multi-channel, on-line cross-correlation analyzer is described. The analyzer generates a pseudo-random code for perturbing the system, records output signals from up to ten points of the system, performs cross correlations on up to four of the points, and displays the four correlograms simultaneously on an oscilloscope. (D.C.W.)

17187 INZHENERNYE RASCHETY YADERNYKH REAKTOROV. (Technological Calculations of Nuclear Reactors). A. L. Kramerov and Ya. V. Shevelev. Moscow, Atomizdat, 1964. 716p.

The methods for thermal and hydromechanical engineering calculations of nuclear reactors are discussed. Problems associated with thermal stresses and strains, analysis of nonstationary processes, and reactors with boiling and nonboiling heat carriers are considered. A detailed description is given of the effect of various random deviations from calculated conditions on the output characteristics of a reactor (the mechanical factors). Besides the calculations, the problems that are associated in one way or another with the selection of the best engineering calculations are cited. The selection of the optimal parameters is also considered. (ATD)

17188 CONTAINMENT FOR SITING IN DENSELY POPULATED AREAS. F. Malay (Westinghouse Electric Corp., Pittsburgh) and C. T. Chave. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-1, 12p, $1.00. (CONF-763-35)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Various technological and siting aspects of commercial nuclear power plants are delineated and discussed, with emphasis on reactor containment. Government regulations concerning plant safety and siting criteria are reviewed and the desirability of plant siting near load centers is considered. A double-containment concept is described that makes possible the siting of nuclear power stations in areas of high population density. Design requirements, test, and inspection procedures are outlined and discussed. Various subsystems of the reactor containment are presented, with emphasis upon their engineered safeguards to further assure containment integrity and safety to the public. (auth)

Auxiliaries and Components

Refer also to abstracts 15553, 15857, 15994, 16044, 16187, 17156, 17321, 17322, 17323, 17324, 17325, 17326, 17380, 17382, 17384, and 17385.

17189 (HPR-43) ELECTRICALLY HEATED BOILING TEST LOOP. H. N. van Leeuwen (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Sept. 1964. 97p. Dep.(mn).

The boiling test loop was designed to simulate conditions in the Halden BWR. The loop is operated with instrumented, electrically heated mock-ups of reactor fuel assemblies. The unique features of the loop include "in-core" instruments, glass-viewing parts, axial power distributions, etc. Two experiments were conducted to determine the steady-state hydraulic performance of the tubular geometry section, and to study downcomer flashing in the loop. The future test program for the loop is also described. (D.L.C.)

17190 (NAA-SR-Memo-10922) SHØE — A SHIELD WEIGHT OPTIMIZATION CODE. R. L. Bernick (Atomics International, Canoga Park, Calif.). Jan. 15, 1965. Contract [AT(11-1)-Gen-8]. 59p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The SHØE code, a FORTRAN computer code designed to calculate the optimum dimensions of a 3-region laminated radiation shield surrounding a spherical reactor core, is described. The method of optimization employed is a modification of the method of steepest descent. A listing of the code and the input and output for a sample problem are included. (auth)

17191 DEVELOPMENT IN TESTING OF BURST CARTRIDGE DETECTION GEAR. T. Conway. Nucl. Eng., 9: 445-9(Dec. 1964).

Work is described on operational reactors which provides a good correlation between design predictions and observed behavior of burst cartridge detection equipment. Recent development work indicates a relation between fuel element can contamination, fission product background signal from can contamination, and fuel element surface area, for all existing magnox reactors. A method by which sensi-

tivity of burst cartridge detection gear can be specified and measured in operational terms was developed. (M.J.T.)

17192 STRENGTH PROBLEMS OF REACTOR STEEL PRESSURE VESSEL OF LARGE DIMENSIONS. Jaroslav Nemec (Technical Univ., Prague). Nucl. Struct. Eng., 1: 197-205(Feb. 1965).

The production of an operationally reliable pressure vessel for reactors is one of the difficult tasks encountered in many projects of large nuclear power stations. These steel vessels have large dimensions (diameters from 3 to 8 m) and a comparatively high internal pressure so that the basic wall thickness sometimes amounts to several tens of centimeters. According to the type of nuclear reactor it is possible to divide the pressure vessels into those operating at high temperature (> 250°C) and at low temperature (< 250°C). The second group of vessels, where it is not necessary to consider the creep of metals, is discussed. In particular, the effect of size on the quasi-brittle strength of pressure vessel steel and the effect of pulsating loads on the strength of vessels are discussed. It is emphasized that the selection of materials, shape, and size for large welded reactor pressure vessels by only standard tests of mechanical properties of materials performed with small test specimens is completely inadequate. Special attention is called to the importance of the size factor. (auth)

17193 A STATUS REPORT ON PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL TECHNOLOGY. M. Bender (Oak Ridge National Lab., Tenn.). Nucl. Struct. Eng., 1: 206-23(Feb. 1965).

The evolution of concrete pressure vessel design is traced, and a summary of the current applications of prestressed concrete for reactor pressure vessels is presented. Important design considerations and methods for design evaluation are discussed. It was concluded that a basis for design compatible with the ACI and ASME pressure vessel codes is evolving, but the maximum pressure limits for which prestressed concrete can be used are yet to be established. (auth)

17194 SENSING AND CONTROL INSTRUMENTATION. A. Pearson and C. G. Lennox (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.285-416 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

A survey is presented of the philosophies, requirements, and designs of nuclear and non-nuclear instrumentation, reactivity-control instruments, radiation-monitoring instruments, and computational equipment for reactors. The distribution of electrical input power to the reactor is also discussed. 239 references. (T.F.H.)

17195 PHYSICS AND MATERIAL PROBLEMS OF REACTOR CONTROL RODS. Proceedings of the Symposium Held at Vienna, 11-15 November, 1963. (International Atomic Energy Agency, Vienna (Austria). Proceedings Series. June 1964. 801p. (STI/PUB/81). $15.00; Sch 315,-; 90s. stg; F.fr. 60,-; DM 52,50(IAEA). (CONF-263)

Thirty-four papers are included; separate abstracts have been prepared for 30. Four papers were previously abstracted in NSA, vol. 18, as abstracts no. 1189, 19375, 19424, and 42889. (T.F.H.)

For abstracts of individual papers see: 16044, 16187, 16188, 16189, 17196, 17197, 17198, 17199, 17200, 17201, 17202, 17203, 17204, 17205, 17206, 17207, 17208, 17321, 17322, 17323, 17324, 17325, 17326, 17355, 17380, 17381, 17382, 17383, 17384, and 17385.

17196 THEORY OF CONTROL RODS IN MULTI-REGIONED REACTORS. T. B. Enginol (Institut fur Reine und Angewandte Kernphysik, Kiel). p.3-17 of STI/PUB/81.

A mathematical method for evaluating the effect of control rods on the criticality of a multi-regioned reactor and its numerical application is discussed. To begin with, a general theory of control rods in the multi-regioned reactor is given. In the search for the possibilities of a numerical approximation and its limiting assumptions, it is desirable to know the exact formulation of the problem. This analytical treatment delivers a critical determinant of infinite rank, the special cases of which are discussed. The possibility of obtaining an approximating finite determinant for numerical computation is sought. For a search of the approximation possibilities, a single region of the reactor is considered, and the ratios ϕ/ϕ' for the fluxes at the boundaries are defined as parameters; thus the criticality conditions of the single zone with the control rods is obtained, which makes an indirect comparison between the orders of approximation possible. The critical determinant obtained for the multi-regioned reactor is then used for computation of the reactivity worths of control rods with various numbers, configurations and radii in a three-regioned reactor. The reactivity worths of the control-rod systems are obtained with the digital computer Z-22, where the zero point of the corresponding critical determinant is found as the eigenvalue ν (mean number of secondary neutrons per fission). (auth)

17197 ONE- AND TWO-GROUP MODELS FOR THE REACTIVITY OF EQUALLY SPACED RADIAL CONTROL PLATES IN A REACTOR. J. M. Doederlein and H. Nishihara (Institutt for Atomenergi, Kjeller, Norway). p.19-44 of STI/PUB/81.

One- and two-group models, developed along the lines of generalized Nordheim-Scalettar methods are presented, for the reactivity equivalence of fully inserted, equally spaced radial control plates in a homogenized reactor. By application of the Hurwitz-Roe absorption-area concept, the models can also be applied to other forms of control elements, e.g., cylinders and cruciforms. The one-group model is applied to numerical studies of six- and eight-plate configurations. It is shown that for these systems strong plate-interaction effects may be expected. (auth)

17198 APPLICATION OF HETEROGENEOUS AND HOMOGENEOUS METHODS IN THE CALCULATION OF CONTROL ROD EFFECTS IN D_2O LATTICES. T. Skardhamar (Aktiebolaget Atomenergi, Studsvik, Sweden). p.45-70 of STI/PUB/81.

The application of heterogeneous and homogeneous calculation methods in the determination of control-rod effects in natural-uranium, heavy-water-moderated cores is discussed with reference to experiments performed in the Swedish R0 reactor. The experiments, involving the determination of the reactivity effects on both fully and partially inserted absorber rods in different lattices, are used for comparison with the results of calculations in which the individual control and fuel rods are treated by source-sink theory, and the medium surrounding the control rods is treated as homogeneous. The agreements between the results from these theoretical treatments and the accuracy with which they predict the control-rod reactivity effects in heavy-water lattices are discussed. (auth)

17199 THEORETICAL AND EXPERIMENTAL STUDY OF THE EFFICIENCY OF THE CONTROL-ROD SYSTEM IN A REACTOR WITH REFLECTOR. N. N. Ponomarev-Stepnoi and V. I. Nosov. p.141-51 of STI/PUB/81. (In Russian)

The calculation results obtained in a multi-group diffusion approximation are compared with the experimental values for the efficiency of individual, boron-containing, absorbing control rods and of systems of such rods arranged in the radial reflector of a homogeneous, cylindrical, thermal-neutron reactor. There is agreement between the theoretical and the experimental results. It is shown that the contribution of epithermal absorption to the efficiency of cylindrical, solid control rods of the geometrical dimensions studied ($2a_{rod} \leq 3$ cm) is about 30%. The three-group diffusion approximation method of calculating such systems is generalized for the case of arbitrary arrangement of the control rods in a radial reflector. (auth)

17200 MEASUREMENTS OF CONTROL ROD WORTHS IN CRITICAL AND EXPONENTIAL ASSEMBLIES. K. Bjoereus, R. Persson, and C. Wikdahl (Aktiebolaget Atomenergi, Studsvik, Sweden). p.173-201 of STI/PUB/81.

Control rods of cadmium, stainless steel, and a Cd–In–Ag alloy have been investigated by means of three different methods: measurements of buckling differences and migration areas in a zero-power reactor (R0); pulsed subcritical measurements in R0 with a compact neutron pulse generator; and buckling measurements in an exponential assembly (ZEBRA). The measurements were made in different lattices of natural uranium metal rods and heavy water. Radial and axial statistical weights for one and two control rods were measured by means of the first method with an accuracy in ΔB^2 of 0.005 m^{-2}. The upper limit in the value of ΔB^2 is about -1.5 m^{-2}, equivalent to -4% of reactivity. The accuracy in the pulsed measurements is of the order of 5%, but in this case it is possible to measure very large negative reactivities. In the exponential assembly an attempt is made to separate the thermal and epithermal absorption effects by measuring the control-rod worths with only moderator in the tank as well as in different reactor lattices. The accuracy was of the same order as in the critical measurements. (auth)

17201 DESIGN, FABRICATION AND PERFORMANCE OF BORON–CARBIDE CONTROL ELEMENTS. H. A. Brammer and J. Jacobson (General Electric Co., San Jose, Calif.). p.381-407 of STI/PUB/81.

A control blade design, incorporating boron–carbide (B_4C) in stainless-steel tubes, was introduced into service in boiling-water reactors. This blade is the standard reference control element in General Electric boiling-water reactors, replacing the 2% boron–stainless-steel blades previously used. The blades consist of a sheathed, cruciform array of small vertical stainless-steel tubes filled with compacted boron–carbide powder. The boron–carbide powder is confined longitudinally into several independent compartments by swaging over ball bearings located inside the tubes. The development and use of boron–carbide control rods is discussed in five phases: experience with boron–steel blades and reasons for transition to boron–carbide control; design of the boron–carbide blade, beginning with developmental experiments, including early measurements, through a description of the final control blade configuration; fabrication of the blades and quality control procedures; confirmatory pre-operational mechanical and reactivity testing; and post-operational experience with the blades, including information on the results of mechanical inspection and reactivity testing after two years of reactor service. (auth)

17202 SUITABILITY OF CADMIUM TANTALATE AND INDIUM TANTALATE AS CONTROL MATERIALS FOR HIGH-TEMPERATURE REACTORS. E. Preisler, F. Haessner, and G. Petzow (Max-Planck-Institut fur Metallforschung, Stuttgart). p.463-85 of STI/PUB/81.

Control materials for practical use in high-temperature reactors should, independently of the requirements of the individual case, have the following properties: high absorption cross section for neutrons in a wide range of energies; high absorption capacity for neutrons; small sensitivity for radiation damage; good thermal resistance; low reactivity with the environment; and low costs and good availability. With these points and the avoidance of the disadvantages of (n,α) reactions taken into consideration, attention is paid chiefly to the elements cadmium, tungsten, indium, and tantalum. It is important to combine a good thermal absorber with an epithermal absorber so that the resulting material is stable at elevated temperatures ($\gtrsim$700°C). For this purpose the double-oxides $CdWO_4$, $Cd_2Ta_2O_7$, and $CdIn_2O_4$ are suitable. Among these, cadmium tantalate has the highest thermal resistance. Another double-oxide which, in combination with cadmium tantalate, possesses an advantageous absorption spectrum for neutrons is indium tantalate. It has also good thermal resistance. Because ceramic absorber materials often have to be shaped by plastic deformation, they usually are used as cermets. Therefore, they must be compatible with metals. Cadmium tantalate is compatible with silver and copper and up to 700°C with nickel; and indium tantalate is completely compatible with silver, copper, and nickel, up to 700°C with molybdenum, and to some degree with iron. These results are in agreement with thermodynamic calculations. For an estimation of the behavior of the absorber materials under reactor conditions and daughter products originating from neutron absorption have to be considered. While ^{113}Cd transforms into the stable ^{114}Cd, tantalum transmutes into tungsten and indium into tin. Both daughter products can bind more oxygen in their most stable valency states than the parent elements can. Therefore, the reduction of Cd^{2+} to metal can be expected while indium tantalate should be stable. This has been confirmed by experiments with SnO- and WO_3-additions to cadmium tantalate. Addition of copper oxide to the compounds suppresses this effect. (auth)

17203 DESIGN AND EXPERIMENTAL EVALUATION OF AN ELECTROMAGNETIC ACCELERATION SYSTEM FOR FAST SAFETY RODS. P. Dosch, H.-J. Kraus, and H. Uhrig (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Ger.). p.571-89 of STI/PUB/81.

The safety system of a reactor must have a very short delay time if it is to control very fast reactivity disturbances. The electronic parts of a safety system may be equipped with short response times very easily, whereas reduction of the mechanical release time of the safety rod is a difficult task. More exact investigations show that, besides the short release time, high initial speed of the rod would be an advantage. At equal total times of insertion a rod having uniform velocity is by far superior to a rod having uniform acceleration. From this it is seen that a pulse-shaped acceleration is the proper way of driving safety rods to meet fast reactivity disturbances, because such acceleration takes care of short delay times and provides high initial velocities. An electromagnetic pulse generator was found to be suitable for application in safety rods. It features these advantages: the components are few and of simple and sturdy design, which may easily be included in a safety rod and can also be designed for conditions near the core (high levels of temperature and radiation); driving energy is stored in an electric capacitor and thus is also available in case the power supply fails; and the design can easily be made in such a way as to permit an unrestricted free fall in case the pulse fails. The results of experimental investigations conducted in electromagnetic pulse generators are described. It is possible to accelerate a safety rod after less than a millisecond to initial speeds of several meters per second, depending upon the weight of the rod. The design of a fast safety rod for a fast zero-energy assembly (SNEAK) is described. A prototype of this safety rod is being tested. (auth)

17204 THE DESIGN OF CONTROL-ROD DRIVES FOR LARGE GRAPHITE-MODERATED REACTORS. G. E. Wade (General Electric Co., Richland, Wash.). p.591-616 of STI/PUB/81. (HW-SA-3089)

Because graphite-moderated tube-type power or desalinization reactors are more economical in the larger ratings, control-rod drives may require strokes in the 20 to 60 ft range. Speed-of-insertion requirements may vary by a factor of 300 to 1 between the low-speed normal control requirements and the high-speed emergency shutdown requirements. Internal rod cooling is often required in addition to the prevention of reactor atmosphere leakage where the control rod penetrates the reactor envelope. These requirements in addition to those of rod deceleration, shielding, space limitations, stored or emergency energy sources, maintenance provisions and overall drive-system cost increase the design problems associated with control rods for this type of reactor. Several unique control and/or shutdown rod drives have been designed for horizontal and vertical operation in large graphite-moderated power and study reactors. These designs include: air-operated shutdown rods with high insertion speeds; hydraulic motor-driven, chain-type shutdown control rods with short storage sections and a compact drive; and hydraulic cylinder-operated, force-multiplication shutdown control rods. Each of these drives compromises the requirements listed above to some extent; however, operable drives have been designed and tested. (auth)

17205 THE CONTROL OF FAST REACTORS: CURRENT METHODS AND FUTURE PROSPECTS. W. B. Loewenstein (Argonne National Lab., Ill.). p.633-67 of STI/PUB/81.

The practical aspects of providing adequate reactivity for the control of fast reactors which differ significantly from those used to control thermal-neutron systems are discussed. These differences result primarily from the rather small fast-neutron cross sections. There are no strong poisons in a fast-neutron system. As a result, the strong thermal-reactor fission-product poisons (e.g., Xe and Sm) require significantly less reactivity override than the reactivity loss from destruction, by fission and capture, of fissionable material. Because the fast-spectrum atomic cross sections are relatively small compared with their thermal counterparts, the atomic density of the material plays an important role in the choice of control materials. The current generation of fast-neutron reactor control mechanisms is described. These tend to exploit neutron leakage control, where applicable. If leakage control is not feasible, control by moving of core material has found considerable acceptance. Limited absorber control is also being used. None of these methods has significant advantages for application to the large conceptual central-station power-breeder reactor system unless the internal (core) breeding ratio is very high. Exploratory results pertaining to the advanced systems are cited. The reactivity for control is dictated by reactor shutdown requirements, the reactor fuel cycle (excess reactivity) and, to a lesser extent, the dominant feedbacks. The excess reactivity requirements can be quite well specified in terms of a given fuel cycle but may vary considerably for several similar systems operating on different fuel cycles. The required shutdown reactivity may be almost arbitrarily specified beyond certain limits. However, there are certain philosophical implications which prevail regarding the specification of this parameter. These considerations are discussed in terms of control reactivity in existing fast reactors as opposed to the amount that is really required for fast power-breeder reactor operation. Typical power- and temperature-dependent feedback parameters are cited for determination of their influence upon the control reactivity requirements. The methods used to predict the reactivity worth of control mechanisms have evolved from crude estimates to quite reliable calculations which can be confirmed by experimental data from critical assemblies. Experimental results and currently reliable analytical techniques are described. Critical experiments for the current generation of fast reactors included many investigations pertaining to the reactivity worth of their control mechanisms as well as peripheral experiments for larger-core-volume advanced systems. Exploratory analytical studies, which indicate that detailed experimental mockup investigations may not be required in the future, are cited. (auth)

17206 HYDRAULIC-BALL (HY-BALL) CONTROL SYSTEM. S. J. Weems, J. M. West, S. E. Turner, and R. L. Lyerly (General Nuclear Engineering Corp., Dunedin, Fla.). p.669-87 of STI/PUB/81.

The Hy-Ball control system consists of a large number of small tubes vertically penetrating the active core region; the tubes contain movable poison elements (either spherical or cylindrical), which are hydraulically lifted upward from within the active core region to increase core reactivity. Reactor water is the actuating fluid. Hy-Ball columns occupy fuel-element lattice positions in a homogeneous fuel-element configuration. This configuration, with finely subdivided control elements, practically eliminates local water-hole power peaking and provides good control of the radial power distribution. By limitation of the amount of reactivity controlled by a single Hy-Ball column assembly to 0.1% or less, it is unnecessary to operate the poison elements in any position other than either the fully inserted or fully withdrawn positions. Elimination of intermediate positions results in simplicity of the system and avoids the inherent axial power perturbation resulting from partially inserted control elements. Physics studies indicate that up to about 40% more power can be obtained from a Hy-Ball-controlled core than from a core with conventional control rods. Tests simulating all reactor operating conditions except radiation are being performed for evaluation of costs, operational characteristics and long-term reliability effects. (auth)

17207 A STUDY OF FLUIDIZED-BED CONTROL RODS. D. J. Blair, M. J. Driscoll, G. R. Dalton, and T. F. Parkinson (Univ. of Florida, Gainesville). p.689-702 of STI/PUB/81.

Control of nuclear reactors with fluidized-bed control rods (FBCR) has been previously proposed; but, despite some apparent advantages over electromechanical systems, such rods have not received widespread attention. With the FBCR concept, the reactor control system becomes a flow-regulating system using either variable-speed pumps or motor-driven control valves in the main coolant. Alternatively, in-core by-pass piping similar to control systems now being developed for fluidized-bed reactors may be utilized. Some of the possible advantages of the FBCR concept are as follows: most pressure-vessel head penetrations are eliminated, and refueling is simplified; automatic scram results from a loss-of-flow accident; axial power can be shaped by the use of contoured channels or variable-sized particles; water-gap flux peaking can be reduced for the partially withdrawn control rod; the temperature reactivity allowance may be reduced if the fluidized control rods have a negative temperature coefficient; and fabrication costs are much lower than for electromechanical systems. An evaluation of the FBCR concept, including construction of prototype models and testing of the hydraulic and nuclear characteristics, has been performed. Two types of rods were studied: transmission rods (thickness ≤ 2 mean free paths) and reflection rods (thickness ≤ 4 mean free paths). Acceptable hydraulic and nuclear characteristics are possible with both types. The feasibility of controlling low-power reactors by either transmission- or reflection-type fluidized-bed control rods has been established. Furthermore, it was shown that the FBCR concept has good control properties which may be calculated by standard theoretical methods. For high-power, high-temperature applications, additional information on particle material characteristics is needed. A great advantage offered by the FBCR is the possibility of shaping the axial flux either by the use of particles of differing size and absorption or else by appropriate shaping of the FBCR cross sectional data. (auth)

17208 USE OF A GAS UNDER VARIABLE PRESSURE TO CONTROL REACTIVITY IN POWER REACTORS. M. Lagrange, L. Dolle, J. P. Satre, and G. Dirian (Commissariat a l'Energie Atomique, Paris). p.733-69 of STI/PUB/81. (In French)

A gas with a high thermal-neutron-capture cross section and a pressure capable of varying sufficiently to meet reactivity demands can be used to control reactivity. The gas is contained in a circuit consisting of several parallel tubes that pass through the reactor core. Local dips in the neutron flux are thus minimized as compared with those produced by solid control rods. A description is given of the way in which the gas control rod circuit operates. It is planned to use helium-3 in the gas rod circuit. The problems raised by its behavior under the effects of neutron radiation in such a circuit are examined. Continuous elimination of the tritium formed by the thermal-neutron capture reaction is simple and economical. The physical chemistry of recoil atoms in the presence of atmospheric impurities is quantitatively examined. (auth)

17209 A CONTRIBUTION TO GAS EJECTOR DESIGN. D. Costes (CEN, Saclay) and J. R. Fellous. 21p. (CONF-640504-1)

From American Society of Mechanical Engineers, Fluids Engineering Conference, Philadelphia.

Optimization calculations for the design of a gas ejector for a nuclear fuel test loop were checked by tests on a mixer operating with ambient air. The results are pre-

sented, and a method is proposed for optimizing the mixer diameter. (D.C.W.)

17210 ROD DRIVE FOR NUCLEAR REACTOR. Jack F. Shannon (to Bailey Meter Co.). U. S. Patent 3,154,472. Oct. 27, 1964. Filed Mar. 7, 1960.

The fluid drive apparatus patented will move the control rod for a nuclear reactor to scram position without auxiliary power in case of emergency; it is intended to be fail-safe. Completely modulated operation throughout the travel of the control rod is provided, and the drive mechanism may be readily connected and disconnected from the control rod. The rod drive is particularly applicable to pressurized water reactors wherein the water in the primary loop may be used as the operating fluid and the need for buffer seals and other auxiliary components is eliminated. The apparatus is suitable for marine and other mobile uses because it is virtually unaffected by the motion of the reactor vessel. (A.G.W.)

17211 PREHEATING AND COOLING A NUCLEAR REACTOR SYSTEM. Donald C. Schluderberg (to Babcock and Wilcox Co.). U. S. Patent 3,155,595. Nov. 3, 1964. Filed Dec. 4, 1959.

An apparatus for selectively preheating a nuclear reactor system before startup or cooling it after shutdown is patented. The various components of the nuclear reactor system are enclosed in a fluid-tight shell. A conduit system is connected to the shell to pass a heat transfer fluid through the flow space between the reactor parts and the shell. Within the conduit system, a heat source and a cooler are arranged in parallel, and valves are positioned to direct the fluid to either the heater or the cooler. A monitoring system may be combined with the apparatus to detect leakage in the reactor system. (A.G.W.)

Criticality Studies

See also PHYSICS — Criticality Studies.

Refer also to abstracts 16438 and 17367.

17212 (AEET/HP/Th-18) BUILD-UP OF NUCLIDES IN CYCLIC NUCLEAR OPERATIONS. MATHEMATICAL FORMULATION. P. P. Damle, D. V. Gopinath, and A. K. Ganguly (Atomic Energy Establishment, Trombay (India)). 1964. 27p. Dep.(mn).

General and exact expressions for the build-up of the n^{th} member of a radioactive chain in cyclic nuclear operations have been derived. The expressions take into account the possible modes of depletion of the chain members. (auth)

17213 (AEEW-M-490) COMPARISON OF CALCULATED AND EXPERIMENTAL RESULTS OF FUEL BUNCHING IN VERA ASSEMBLIES 1B, 3A AND 5A. J. D. Matthews (Atomic Energy Establishment, Winfrith (England)). Dec. 1964. 15p. Dep.; $0.50(BIS); 2s. 6d. (HMSO).

Comparison is made of experimental and calculated reactivity changes when the fuel plates of the VERA assemblies are bunched from ⅛" thickness to ¼". In addition, ^{238}U fine structure reaction rates are studied. The method used is that investigated in detail by James and Matthews while the multigroup data sets used are both those of Yiftah, Okrent and Moldauer, and Roach. The method and data give only rough agreement with experimental reactivity changes, with a tendency to over-predict the results. The ^{238}U fission rates are in better agreement, though the method predicts too small a variation for the ^{238}U capture rate across a cell. (auth)

17214 (CEA-R-2555) ETUDE DU COEFFICIENT DE REACTIVITE LIE A LA TEMPERATURE DU SODIUM DANS LES GRANDS REACTEURS RAPIDES. (Study of the Sodium Temperature Coefficient of Reactivity in Large Fast Reactors). Jean-Marie Chaumont and Jacques Martin (Commissariat à l'Énergie Atomique, Cadarache (France). Centre d'Études Nucléaires). June 1964. 35p. Dep.(mn).

The sodium temperature reactivity coefficient is studied for various geometries, compositions, and enrichments of fast reactor fuel. It shows that among the three components of this coefficient: the first one, associated with neutron capture in sodium, is small, always positive; the second one, associated with neutron degradation through elastic or inelastic scattering of sodium, does not depend upon the geometry but is a function of the enrichment of the fuel and is very sensitive to the definition of effective crossed sections at low energies; the last one, associated with neutron leakage, is always negative; it varies with the geometry in a way which was not expected but rather limits the possibility of reducing a positive sodium coefficient through a core flattening. Some suggestions are made for reducing a positive sodium coefficient such as: introducing a moderator to soften the neutron spectrum, or using another coolant like potassium. Finally some comparisons are made between experimental and theoretical sodium reactivity coefficients. (auth)

17215 (EUR-2105.e) STUDIES IN THE FIELD OF HETEROGENEOUS REACTOR THEORY. G. Blaesser, G. Casini (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center); and G. d'Amico (Milan Univ. (Italy)). 1964. 17p. (CONF-640405-1). Dep.(mn).

From Panel Meeting of the German Atom Forums on Reactor Theory, Karlsruhe, Ger.

Features of the heterogeneous methods for reactor calculations used at the CCR Ispra are presented. The application of such methods for the interpretation of substitution experiments is discussed, and results are given of such an analysis of the substitution measurements performed at Saclay on the Aquilon-II pile with ORGEL-type lattices. (auth)

17216 (EUR-2217.e) TWO-NEUTRON-GROUP KINETIC THEORY AND CALCULATIONS FOR A FAST REACTOR PERIODICALLY PULSED BY REACTIVITY VARIATIONS. T. Asaoka and R. Misenta (European Atomic Energy Community, Ispra (Italy)). Joint Nuclear Research Center, 1965. 40p. Dep.(mn).

For a uranium-metal-fueled and sodium-potassium-cooled reactor with water scatterers in the iron reflector, the mean lifetime of neutrons ranges from 30 to 60 ($\times 10^{-6}$) sec. This rather long lifetime comes from the fact that the value is determined practically by relatively few neutrons slowed down in the water scatterers. Hence, to obtain the characteristics of stationary power pulses with a time-independent amplitude, the familiar one-group space-independent kinetic equation cannot be applied, because these slow neutrons with lifetimes of a comparable order of magnitude to the pulse width will behave in a manner similar to delayed neutrons during the pulse. In order to treat the slow neutrons separately, a two-group kinetic theory has been developed. In the two-group model, the mean lifetime of neutrons in the fast group is of the order of 10^{-6} sec and the low fission probability for neutrons in the slow group can be taken into account explicitly. As a result, the amplitude of stationary pulses has been found to be higher by a factor of about 2 than that obtained from the one-group calculation. (auth)

17217 (IDO-17028) EXPERIMENTAL RESULTS OF POTENTIALLY DESTRUCTIVE REACTIVITY ADDITIONS TO AN OXIDE CORE. J. E. Grund, ed. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Dec. 1964. Contract AT(10-1)-205. 260p. Dep.; $6.00(cy), 5(mn) CFSTI.

The results of two short-period, potentially destructive transient tests performed with a low-enrichment, UO_2-powder, stainless steel clad fuel rod core are presented. The tests were initiated by 2.6- and 3.3-dollar reactivity insertions. In both tests, two fuel rods ruptured and dispersed UO_2 into the water. Approximately 25 percent of the fuel rods also were mechanically deformed or discolored. No appreciable damage to the core structure occurred as a result of the excursions, and only minor fission product release from the ruptured fuel rods was determined. The course of the excursion was predictable from experiment and theory until the fuel rods ruptured.

The rupture of the fuel rods provided additional shutdown to that available from Doppler effects and reduced the expected energy release of the excursions. The cause of the fuel rod ruptures is suspected to have been from "water-logging" Details of instrumentation for the tests and analysis of the experimental results are presented. (auth)

17218 (KAPL-M-6162) CALCULATION OF ΔK FROM NEUTRON FLUX. R. L. Mathews (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 18, 1964. Contract W-31-109-eng-52. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Excess reactivity can be calculated from successive values of the neutron flux by a simple hand calculation. The calculation was coded for the Philco-2000, and is used in the evaluation of the periodic physics tests. (auth)

17219 (NAA-SR-Memo-10632) AIREK-KEWB—A PROGRAM FOR THE NUMERICAL SOLUTION OF THE SPACE INDEPENDENT REACTOR KINETICS EQUATIONS FOR KEWB. L. R. Blue, M. Hoffman, and M. Dunenfeld (Atomics International, Canoga Park, Calif.). Oct. 1964. Contract AT-11-1-GEN-8. 52p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The AIREK-KEWB Program is written in Fortran II to solve space independent reactor kinetics equations, including the reactivity feedback equation, containing quadratic temperature and special void feedback for water boiler reactors, as developed in the KEWB program. This code has graphical output as one of its products. (auth)

17220 (ORNL-TM-1022) BOUNDARY CONDITIONS FOR THE CYLINDRICALIZED CELL OF REACTOR LATTICE CALCULATIONS. J. Wallace Webster (Oak Ridge National Lab., Tenn.). Dec. 30, 1964. Contract [W-7405-eng-26]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

In the solution for the thermal flux distribution in a cylindricalized cell using the one-dimensional spherical harmonic method of third order, several different sets of boundary conditions at the outer surface were proposed in the literature. These are reviewed, and another possible set is derived from a consideration of an analogy between the equations for the moments in cylindrical and plane geometry. None of the possible sets of boundary conditions for the cylindricalized cell satisfies all the physical properties which exist in actual cells, which are necessarily triangular, square, or hexagonal in cross section, these properties being reflection of neutrons, zero current, and zero normal derivative of scalar flux. It is shown, mathematically, why this is so. (auth)

17221 (PAN-560/IX-A) NEUTRON IMPORTANCE MEASUREMENTS IN THE ANNA CRITICAL ASSEMBLY. Jacek Bouźyk, Stanisław Latek, and Witold Suwalski (Polish Academy of Sciences, Warsaw). Inst. of Nuclear Research, Nov. 1964. 18p. Dep.(mn).

The δk/k distributions along vertical and horizontal axis in the ANNA Critical Assembly were measured. Comparing them with square flux distributions and cosine distribution some conclusions concerning neutron importance behavior were reached. The results are useful for practical purposes. (auth)

17222 (UCRL-12261) SINGLE-PULSE TIME-OPTIMAL SOLUTION OF THE REACTOR SHUTDOWN PROBLEM. Gerald L. Dittman (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 16, 1964. Contract W-7405-eng-48. 52p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Consideration is given to the generation of an optimum shutdown procedure that minimizes the peak xenon concentration. Presented are time-independent representations of xenon and iodine variations in a normalized "phase plane." This representation graphically illustrates the entire range of the xenon and iodine values for either a scram shutdown or full-power excursion. From a qualitative consideration of the phase plane curves, necessary and sufficient general criteria for the optimum shutdown of a reactor are formulated. In addition, a single-pulse shutdown procedure is generated that has been proven to be the optimum shutdown for reactors with sufficient excess reactivity. A digital program has been written that calculates and plots all the equations of interest, determines the optimum one-pulse shutdown, and generates minimum-time one-pulse shutdowns as a function of reactivity burnout. Calculations using Livermore Pool-Type Reactor nuclear data indicate that the reactor can be shutdown using the optimum one-pulse technique without loss of control as is presently the case. (auth)

17223 TRANSIENT PROCESSES AND MEASUREMENTS OF REACTIVITY OF BERYLLIUM-CONTAINING REACTOR. S. S. Lomakin and Yu. A. Nechaev. At. Energ. (USSR), 18: 33-40(Jan. 1965). (In Russian)

The influence of $^{9}Be(n,2n)^{8}Be$ and $^{9}Be(\gamma,n)^{8}Be$ reactions on the kinetics of transient processes in reactors containing beryllium was investigated. Reactor cycle deviations from the asymptotic were measured and calculated. The efficiency of delayed neutrons and photoneutrons was estimated. An integral method was used for measuring reactivity taking into account photoneutrons. (tr-auth)

17224 A METHOD FOR DETERMINING MEAN THERMAL FLUX RATIOS IN A REACTOR LATTICE USING FIRST-FLIGHT COLLISION PROBABILITIES. I. J. Willis (Atomic Energy Establishment, Winfrith, Dorset, Eng.). J. Nucl. Energy: Pt. A and B, 19: 7-16(Jan. 1965).

First-flight collision probabilities are used to determine mean thermal flux ratios for the different regions of a three-region reactor lattice. Usual methods employ transport theory with a cell cylindrical boundary approximation, which is known to overestimate moderator/flux ratio. This approximation is avoided; and in the case of a possible marine reactor lattice with a triangular pitch, the error of the cylindrical boundary approximation is investigated. (auth)

17225 A MATRIX OPERATOR METHOD FOR REACTOR CALCULATION. Yoichi Fujiie (Tokyo Univ. and Hitachi Shipbuilding and Engineering Co., Ltd., Osaka) and Akira Oyama. J. Nucl. Sci. Technol. (Tokyo), 1: 325-34 (Dec. 1964).

As a means of numerically computing neutron flux distribution, a matrix operator method is considered. In this method time, space, and neutron energy are discretized, i.e., considered as discrete variables, and the operators describing the neutron motion are defined in each interval of the discrete variables. The operators consist of space and energy operators, which describe the spatial and the energy distribution of the neutron flux respectively. The operation of these matrix operators on the collision density and the pseudo neutron flux vectors yields the neutron flux distribution of the entire system. This method may be considered an extension to space of the conventional multi-energy treatment, and eliminates tedious procedures to take account of boundary and initial conditions. It eases moreover the selection of time interval from the computational point of view. (auth)

17226 NEUTRON FLUCTUATIONS IN A MULTI-POINT REACTOR. Masuhiko Otsuka and Keiichi Saito. (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 40-2(Jan. 1965).

Fluctuations of the number of neutrons and precursors in a reactor were previously investigated, disregarding the effect of their position and energy. A study was made with the space divided into l meshes and the energy range into n groups; m types of precursors were considered. Results indicated that the neutron population in any system in the ensemble may, with increasing time, deviate from the constant ensemble average, since a just critical system without sources has no "preference" for any population level. (M.C.G.)

17227 ON THE MEASUREMENTS OF SPATIAL DISTRIBUTION OF REACTIVITY COEFFICIENT. Nobuyuki Shirai (Meidensha Electric Mfg. Co., Ltd., Japan). Meidensha Jiho, No. 51, 25-32(Oct. 1963). (In Japanese)

The spatial distribution of reactivity coefficients in the epithermal region was measured in a graphite-moderated critical assembly (SHE). Unlike the foil activation method,

the method used permits free selection of a sample regardless of the activation of nuclei, the mode of decay, and the workability of a foil. If the distribution of neutron fluxes is measured with foils of the same sample, the accompanying function (ϕ) can be estimated from the measurement of the reactivity coefficient. To improve the precision of measurements and shorten the time required for measurement, the sample contained in a Cd filter was pulled out of the core of the assembly by a manipulating system and the reactivity coefficient was measured radially from the core towards the periphery by the period method. In the investigation of the change in the reactivity coefficient due to the neutron absorption in the various energy regions, the following elements were used as samples: Au and In for the low energy region, I and Br for the medium energy region, and Co and Mn for the high energy region. The observed values of reactivity coefficients were compared with the theoretical. Both agreed very well in the core of the assembly, but in the reflector, the theoretical values were smaller than the observed. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

17228 A NEW METHOD FOR EXPONENTIAL EXPERIMENTS. Masafumi Nakano (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 7: 3-7(Jan. 1965). (In Japanese)

A method of carrying out exponential experiments was developed for a cylindrical subcritical assembly of hexagonal lattices. In this method, higher harmonics are excited by an eccentric point neutron source and divided into 4 groups. Then, from the attenuation coefficients of the dominant modes in each group, the material buckling and the effective core radius (or the reflector saving) of the assembly are determined experimentally. Experimental results show that this method is useful for cylindrical assemblies, and the bare homogeneous approximation is rather good even for a subcritical assembly with reflector. (auth)

17229 THE VARIATION OF k_∞ WITH FUEL TEMPERATURE FOR A URANIUM FUEL ELEMENT. R. I. Smith (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 21: 481-9(Apr. 1965).

The change in k_∞ of a heterogeneous lattice caused by a uniform change in the temperature of the fuel was measured, using the Physical Constants Testing Reactor. The test lattice was moderated with graphite and fueled with concentric-tube elements of slightly enriched uranium metal. The temperature of the fuel was varied from 297 to 1241°K. The change in k_∞ with high temperature was nonlinear and could be represented by the relation. $\Delta k_\infty = C[\alpha(T^h - T_0^h) + \beta U(T_{\alpha\beta}) + \gamma U(T_{\beta\gamma})]$, where T is in degrees Kelvin. The experimentally measured values of the constants were $\alpha = (-0.308 \pm 0.004)$, $\beta = (-0.120 \pm 0.004)$, $\gamma = (-0.085 \pm 0.004)$. The unit functions, U, represent the changes in k_∞ caused by the isothermal volume expansion of the fuel element when the uranium metal undergoes transformations in its crystal structure from alpha to beta and from beta to gamma phases. The term C is a normalization factor related to the lattice under study. The reactivity techniques employed here are shown to be four times more sensitive than activation methods for determining the functional relationship between the effective resonance integral of a fuel element and the temperature of the element. The constant, α, was experimentally separated into two components: $\alpha_\gamma = (-0.240 \pm 0.04)$, which is associated with the average interior temperature of the fuel, and $\alpha_s = (-0.068 \pm 0.04)$, which is associated with the temperature of the surface of the fuel. This separation allows treatment of nonuniform temperature distribution in the fuel. (auth)

17230 NONLINEAR REACTOR KINETICS ANALYSIS. H. L. Garabedian and R. E. Lynch (General Motors Corp., Warren, Mich.). Nucl. Sci. Eng., 21: 550-64(Apr. 1965).

This study is concerned with two-group reactor kinetics in a multiregion reactor for problems which involve time-dependent coefficients and nonlinear terms. The method of solution described can be used in problems in which the cross sections are given as linear combinations of powers of the fluxes or as powers of the integrated fluxes. Numerical integration schemes are suggested to solve this class of problems. Included in the possible inherent shutdown mechanisms of a reactor is the Doppler broadening of absorption resonances. It is this particular phenomenon that is used in a model problem to illustrate techniques that may be used to solve a much wider class of problems. The model problem is based on two-group diffusion theory, with one group of delayed neutrons, in a multiregion slab reactor. The results obtained are readily extensible to cylindrical and spherical geometries in one space variable. (auth)

17231 THE DETERMINATION OF REACTOR DISPERSION LAWS FROM MODULATED-NEUTRON EXPERIMENTS. M. N. Moore (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 21: 565-74(Apr. 1965).

The propagation of neutron waves through homogeneous nuclear systems, multiplying or non-multiplying, is studied with the aid of the general linear model. This model is characterized by a relation between the complex wave length and frequency, a dispersion law. It is shown that, independent of the geometry of the system, the nature of the propagation and hence the neutron wave optics of the medium, is governed by this dispersion law. It is also shown how this dispersion law can be measured in the general situation, using spectral analysis and modal decontamination techniques. When specialized to particular geometries, but not to particular systems, the possibility of stop-and-pass frequencies emerges. When specialized still further to a multiplying system governed by age-diffusion theory, a new criterion for criticality is found. This latter should be of interest in monitoring the approach to critical condition in a large reactor whose kinetics are spatially dependent. (auth)

17232 COMMENTS ON THE EXISTENCE OF EXCEPTIONAL FREQUENCIES IN MULTIPLYING MEDIA. R. L. Brehm (Univ. of California, Los Angeles). Nucl. Sci. Eng., 21: 575-6(Apr. 1965).

It is shown that, within the framework of the age-diffusion model, for thermal reactor systems characterized by a thermal diffusion lifetime at least as large as the slowing-down time, all non-zero exceptional frequencies are stop frequences. A minimum non-zero stop frequency exists, which is related to the slowing-down time by $\omega_{min} > \pi/l_\tau$, where l_τ is the slowing-down time. (D.C.W.)

17233 MULTILEVEL CROSS SECTIONS AND REACTOR CRITICALITY. M. Goldsmith and N. R. Candelore (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 21: 576-8(Apr. 1965). (WAPD-T-1719)

The effect of using the approximate Breit-Wigner single-level formula for representing resonances on criticality calculations was studied by considering the fission/absorption ratio in a pure ^{235}U fuel element. Absorption cross sections and fission/absorption ratios obtained with the single-level formula were compared with results obtained with a multilevel formula. (D.C.W.)

17234 A MODIFIED KANTOROWITSCH METHOD FOR THE DIFFUSION THEORETICAL CALCULATION OF REACTORS WITH COMPLICATED GEOMETRIES. PART I. Hermann Schaeffler (Technische Hochschule, Stuttgart). Nukleonik, 6: 384-95(Dec. 1964). (In German)

For reactors with complicated geometry, as is present, for example, on account of any control elements (rods or plates) introduced in the reactor, the diffusion equation is not soluble analytically. An approximation method must be used. The modified Kantorowitsch method makes it possible to calculate a large class of such non-separable geometries. It differs from the approximation methods used in the literature in that it makes it possible to obtain very accurate results at relatively low expenditure. The calculation time amounts, in the modified method, to only a fraction of the time necessary for other methods. It is possible to calculate complicated problems in practicable calculation time. The method depends on a new formulation by means of which the variation problem equivalent to

the differential equation problem can be solved approximately. The method was demonstrated on the example of a bare cylinder reactor with central partially inserted black control rod and a reactor with re-entering angles. (tr-auth)

17235 A MODIFIED KANTOROWITSCH METHOD FOR THE DIFFUSION THEORETICAL CALCULATION OF REACTORS WITH COMPLICATED GEOMETRIES. PART II. Hermann Schaeffler (Technische Hochschule, Stuttgart). Nukleonik, 6: 395-405(Dec. 1964). (In German)

The modified method was discussed for some special control rod positions. It was applied to a reactor with re-entering angles and expanded to some further geometries. Numerical results were given for the eigenvalues and compared with values from the literature. (tr-auth)

17236 THE DETERMINATION OF THE INTEGRAL FLUX DENSITY IN IRRADIATIONS IN REACTORS. Wilfried Koehler (Technische Hochschule, Munich). Nukleonik, 6: 405-14(Dec. 1964). (In German)

After an explanation of the necessity of an experimental determination of the integral flux density (I.F.D.), the various measurement methods were described. The discussion of the energy dependence of the possible detectors and the irradiation experiments showed that a determination of the I.F.D. for slow neutrons is possible with several methods. As an example, the cobalt method already used in many studies was described completely. For the region of neutrons, that are responsible for the change of physical properties in metals, the activation method with threshold-value detectors is possible, but not too favorable since these detectors respond first at high neutron energies. A determination of the integral flux density of fast neutrons on the basis of the density alterations of quartz is quite advantageous since this effect shows about the same energy dependence as radiation damage in metals. (tr-auth)

17237 A NEW DIAGRAM REPRESENTING THE EVOLUTION OF GALAXIES. Ko Aizu, Yoichi Fujimoto, Hirotchi Hasegawa, Kin-aki Kawabata, and Mituo Taketani (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 973-4(Dec. 1964).

A diagram is proposed, including the star-like objects, radio galaxies, normal galaxies, and supernova remnants. The evolutional sequences are outlined. (D.C.W.)

17238 A THEORETICAL INVESTIGATION OF JOVIAN UPPER ATMOSPHERE. I. IONIZATION AND DISSOCIATION. Mikio Shimizu (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 977-9(Dec. 1964).

The effect of ionizing solar radiation on the upper atmosphere of Jupiter was investigated, with particular consideration of the dissociation and ionization of molecular hydrogen. The distribution of the hydrogen and electron density was calculated. (D.C.W.)

17239 THE TECHNOLOGY OF NUCLEAR REACTOR SAFETY. VOLUME 1. REACTOR PHYSICS AND CONTROL. T. J. Thompson and J. G. Beckerley (Massachusetts Inst. of Tech., Cambridge). 1964. 754p. $25.00, M.I.T. Press, Cambridge.

Eleven sections and an appendix containing power-reactor safety parameters are included. Separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual chapters see: 17194, 17240, 17241, 17242, 17243, 17244, 17245, 17246, 17247, 17248, 17249, and 17320.

17240 [REACTOR SAFETY]—INTRODUCTION. T. J. Thompson and J. G. Beckerley (Massachusetts Inst. of Tech., Cambridge). p.1-10 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

An outline is presented of the general historical background of nuclear-reactor safety; the basic philosophy of reactor safety; the credibility of independent unrelated failures; the effects of economics on safety; the relation of reactor safety to other types of industrial safety; and the general content of the series of review books of which this is the first volume. (T.F.H.)

17241 THE REACTOR CORE. J. R. Dietrich (General Nuclear Engineering Corp., Dunedin, Fla.). p.11-174 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

A survey is given of elementary concepts of reactor physics; types of reactor accidents, as related to core design characteristics; control; spatial distributions of power; partial and composite reactivity coefficients; effects of core exposure on safety; in-core instrumentation; and specific examples of core design (viz., Shippingport PWR, the first USSR power reactor, Saxton power reactor, Dragon, Calder Hall reactors, Hallan, SRE, NPD, CVTR, Yankee, Big Rock Point, FFBR, and DFR). 264 references. (T.F.H.)

17242 GENERAL REACTOR DYNAMICS. E. P. Gyftopoulos (Massachusetts Inst. of Tech., Cambridge). p.175-204 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

A survey is presented of general aspects of reactor dynamics; analytic techniques used in reactor-safety studies; means for measuring linear dynamic characteristics of reactor systems; and general aspects of representative digital-computer codes used in space-independent reactor-kinetics investigations. 60 references. (T.F.H.)

17243 THE DOPPLER COEFFICIENT. L. W. Nordheim (General Atomic, Div. of General Dynamics, San Diego, Calif.). p.205-43 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Neutron resonance absorption in thermal and fast reactors is surveyed, with emphasis on the Doppler effect. 77 references. (T.F.H.)

17244 CRITICALITY. H. C. Paxton and G. R. Keepin (Los Alamos Scientific Lab., N. Mex.). p.244-84 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

The relations of critical-assembly experience, both experimental and analytical, to reactor safety are studied. An attempt is made to systematize the information available. The use of the multiplication factor as an index of nuclear safety is surveyed. Subcritical reactivity measurements and critical and zero-power operation are studied. Safety considerations for fuels outside reactors are also studied. 100 references. (T.F.H.)

17245 MATHEMATICAL MODELS OF FAST TRANSIENTS. W. E. Nyer (Phillips Petroleum Co., Idaho Falls, Idaho). p.417-45 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Linear and nonlinear models for fast transients in reactors are surveyed. Experimental data from reactor excursions are compared with the predictions of models. 44 references. (T.F.H.)

17246 WATER REACTOR KINETICS. J. A. Thie. p.446-72 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Control, dynamics, power-excursion, and space-dependent dynamics of water reactors are surveyed. 69 references. (T.F.H.)

17247 KINETICS OF SOLID-MODERATOR REACTORS. H. B. Stewart and M. H. Merrill (General Atomic. Div. of General Dynamics, San Diego, Calif.). p.473-529 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

The classification, control, accident sources, excursion analyses, operational problems, and safety aspects of solid-moderator reactors are studied. 65 references. (T.F.H.)

17248 FAST REACTOR KINETICS. Walter J. McCarthy, Jr. (Power Reactor Development Co., Detroit) and David Okrent. p.530-607 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Control characteristics, operational behavior, and dynamics of moderate and severe accidents in fast reactors are surveyed. 110 references. (T.F.H.)

17249 ACCIDENTS AND DESTRUCTIVE TESTS. T. J. Thompson (Massachusetts Inst. of Tech., Cambridge). p.608-708 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Histories, conclusions, recommendations, and comments are presented for several out-of-pile and in-pile criticality accidents. Destructive tests are also described. Operating experience with non-core reactor components is discussed. 94 references. (T.F.H.)

Design and Feasibility

17250 HETEROGENEOUS NUCLEAR REACTOR WITH FUEL ELEMENT RODS. Harry N. Schludi. German Patent 1,181,829. Nov. 19, 1964. Filed Aug. 1, 1961.

A core for a heterogeneous nuclear reactor with fuel element rods is schematically described. In the core the thickness of the cladding and/or the circumference of the fissionable material in a cross section of the rod varies with the height as well as with the radial distance of the rod from the central axis. By this arrangement localized variations of the neutron flux density are compensated. (Gmelin Inst)

17251 METHOD FOR PRODUCING ELECTRIC ENERGY FROM NUCLEAR REACTIONS. Manfred Siebker (to L. and C. Steinmuller GmbH). U. S. Patent 3,155,547. Nov. 3, 1964. Filed Apr. 20, 1959.

A method of producing electric energy from heat derived from nuclear reactions includes circulating steam through a nuclear reactor, dissociating the steam in the reactor by the heat freed in the reactor, separating the dissociated components of the steam, cooling the separated components, converting the potential electrochemical energy of the dissociated components directly into electric energy by means of an electrochemical fuel cell, and effecting a recuperative preheating of the working medium by the heat freed during the cooling off of the separated components. At a point in the circulation system between the reactor and the electrochemical cell a portion of the working medium may be withdrawn and replaced with a fresh portion in order to keep the impurities in the cycle within certain limits. (A.G.W.)

17252 METHOD OF OPERATING A NUCLEAR REACTOR. William A. Frederick (to Westinghouse Electric Corp.). U. S. Patent 3,155,596. Nov. 3, 1964. Filed Dec. 20, 1957.

The two concentrations of fuel at which a nuclear reactor in which fuel concentration can be readily varied can maintain criticality at substantially the same operating temperature are designated respectively as the high and low critical concentrations. A method by which the reactor fuel can be increased from the low critical concentration to the high critical concentration when starting up the reactor without undergoing the usual high temperature peak between these points is presented. The reactor is operated at the low critical concentration until a predetermined quantity of fission products is formed. Operation is terminated for a period of two to ten hours to permit formation of a reactor poison from the fission products. The fuel concentration is then increased to the high critical concentration. For shutting down the reactor, the procedure is essentially reversed with the reactor being rendered subcritical by decreasing the amount of heat withdrawn and allowing the temperature to rise. The method is described in detail for a slurry type homogeneous reactor, but it can be used with any reactor in which the concentration of fissile material can be varied. (A.G.W.)

Fuels

Refer also to abstracts 16001, 16249, 16250, 16366, 16440, 16441, and 16442.

17253 (AD-609177(Sect.F)) SECONDARY ELECTRON YIELDS FROM FISSION FRAGMENTS. (General Motors Corp., Warren, Mich. Research Labs.). 6p.

The secondary electron yield from fission fragments has been measured directly using an ultra-high-vacuum diode containing uranium, operated in a nuclear reactor. The current measured in this diode consisted of contributions from the positively charged fission fragments, secondary electron emission induced by fission fragments, and photoelectrons generated by gamma radiation. The secondary electron yield, Δ, was determined from the secondary electron current and the computed fission fragment emission rate. For a thick (>one range) uranium–nickel (5.7 wt % nickel) alloy the value of Δ is 207 ± 10. (auth)

17254 (CEA-R-2615) COMPTE RENDU ET RESULTATS DES MESURES EFFECTUEES DANS AQUILON II POUR LA JUNTA DE ENERGIA NUCLEAR, JUIN 1963. (A Report with the Results of Measurements Carried Out in Aquilon II for the Junta de Energia Nuclear, June 1963). Pierre Lourme, Rene Jacquemart, and Guy Ledanois (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Nov. 1964. 15p. Dep.(mn).

Buckling measurements have been performed in the heavy water moderated critical facility AQUILON concerning lattices of uranium carbide fuel assemblies. In part of the experiments, these fuel assemblies were sheathed by housing tubes filled with organic to simulate a coolant. Each fuel assembly is a cluster of nineteen aluminum clad, 13 mm diameter UC rods. Experiments were made using substitution method (i.e., critical-approach and pulsed-neutron techniques). Results are compared to analogous lattice calculations and to oxide cluster calculations except for the p factor. (auth)

17255 (EURAEC-1199(Suppl.)) PLUTONIUM RECYCLING. Quarterly Report No. 15. (Commissariat a l'Energie Atomique, Paris, France). [1964]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-13-60-12 RDF. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The development and testing of plutonium–uranium fuel elements for French reactors are summarized. The testing of Saclay Reactor (EL-3) fuel elements in Minerve, Marius, and Aquilon II is discussed. The operation of the research reactors for testing purposes is evaluated. (N.W.R.)

17256 DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT HIGHLY ACTIVE PLUTONIUM EXAMINATION AND REPROCESSING CAVES. R. C. Alexander (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.) and S. A. Cottrell. J. Brit. Nucl. Energy Soc., 3: 215-21(July 1964).

The facilities for investigating plutonium-containing fuels in the Dounreay fast reactor and for design testing of fuel pins and sub-assemblies are described. Physical plant and cave facilities are described. (R.E.U.)

17257 HYDRAULIC INSTABILITY OF FLAT PARALLEL-PLATE ASSEMBLIES. R. J. Scavuzzo (Univ. of Toledo). Nucl. Sci. Eng., 21: 463-72(Apr. 1965). (WAPD-T-1679)

It has been observed that high-velocity coolant flowing through the channels of a parallel-plate fuel assembly will at times cause large deflections of the assembly plates. Hydraulic equations are coupled to the plate equations along the entire length of the assembly. Solution of these coupled equations was accomplished by changing the differential equation developed from plate theory into a non-linear integral equation. The classical method of successive approximations was used to evaluate the integral equation numerically. Numerical results show that plate deflections take place along the entire length of the plate and that local reductions in channel cross section are further reduced by elastic deflections of the plate. (auth)

17258 A SEMI-EMPIRICAL DESCRIPTION OF THE DETAILED THERMAL FLUX DISTRIBUTION IN URANIUM OXIDE CLUSTERS. P. F. Palmedo (CEN de Saclay, Gif-

sur-Yvette, France). Nucl. Sci. Eng., 21: 578-80(Apr. 1965).

The flux distribution at each rod position in clusters of UO_2 rods (7 and 19) was measured, and a semi-empirical expression for the flux distribution was obtained. (D.C.W.)

17259 RADIATION AND CREEP ANALYSIS OF STRAINS AND STRESSES IN ANNULAR FUEL ELEMENTS. Benjamin M. Ma and Glenn Murphy (Iowa State Univ., Ames). Nucl. Struct. Eng., 1: 141-54(Feb. 1965).

A theoretical analysis for determination of strains and stresses produced in long, annular reactor fuel elements is presented. In the analysis, primary effects of thermal-cycling growth, irradiation growth, swelling, creep, and neutron flux levels developed in the fuel material are taken into account. An exact solution based on a product of the modified Bessel functions and the Fourier cosine function, and a simplified, approximate solution of the parabolic function for thermal neutron flux distribution were obtained from the simple diffusion equations. After the rate of volumetric heat generation was determined, the radial temperature distribution in the fuel was found by using Poisson's equation of heat conduction. From some basic assumptions the fundamental equations of displacement-strain relations, compatibility, incompressibility, equilibrium, and yield criterion were established. The strain and stress equations for the fuel elements were derived. From the calculated results of an illustrative example, the neutron flux levels, degree of thermal and radiation dilatation, and thickness and properties of the cladding material were found to have important effects on the strain and stress distributions produced in the fuel elements. (auth)

17260 FUELS AND FUEL ELEMENTS FOR REACTORS. MATERIALS AND PRODUCTION PROCESSES OF A NEW TECHNOLOGY. Schriftenreihe Deut. Atomforum, No. 12, 1-62(1963). (In German)

Popular articles on the fuels and fuel elements for reactors are presented. Uranium and its history, uranium occurrence and reserves, nuclear fuel materials, and fuel elements are discussed. (J.S.R.)

17261 NUCLEAR FUEL ELEMENTS AND MANUFACTURING METHOD. Harold H. Klepfer and Millard E. Snyder (to General Electric Co.). Canadian Patent 702,179. Jan. 19, 1965. Filed Sept. 12, 1961.

The clad notching problem was avoided in a fuel element design by closing the ends of the fuel tube with hollow plugs containing porous metallic material, which absorbs the gaseous fission products. The cladding is zirconium and the fuel is UO_2 pellets. Only moderate increases in internal pressure occurred in service, because, the fission gases were absorbed in the hollow. Low-temperature manufacturing techniques prevented notching at the junction of the cladding and end plug. (F.S.A.)

Power and Power-Breeder Reactors

Refer also to abstracts 15889, 16010, 17204, and 17208.

17262 (ACNP-64016) PATHFINDER ATOMIC POWER PLANT. BOILER FUEL ELEMENT DESIGN REPORT. D. A. Patterson, W. J. Severson, D. R. Roberts, and R. H. Klumb (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jan. 8, 1965. For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 98p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The mechanical design of the boiler fuel element assemblies comprising the first boiler core of the Pathfinder Reactor is described. The design requirements are also given. (T.F.H.)

17263 (ACNP-65503) FINAL HAZARDS REPORT FOR THE RCPA ELK RIVER REACTOR. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jan. 14, 1965. Contract AT(11-1)-654. 298p. Dep.(mn); $6.00 (cy), 5(mn) CFSTI.

The design and operation of the Elk River Power Reactor are described, with emphasis on the safety hazards to be expected and means for their mitigation and/or removal. (T.F.H.)

17264 (AD-422953) ECONOMICS OF ZIRCONIUM ALLOY VERSUS STAINLESS STEEL NUCLEAR FUEL SHEATHING. D. L. Trapp (RAND Corp., Santa Monica, Calif.). Nov. 1963. 19p. (CONF-631106-1).

From Seminar on Zirconium Alloys, Wallingford, Conn.

Increasing the uranium carrying charge from 4.75%/yr to 12%/yr raises the fuel-cycle cost by about 0.5 mill/kwh(e) with stainless-steel cladding and 0.25 mill/kwh(e) with zircaloy. The optimum burnup becomes lower with higher carrying charges. For all cost bases, fuel-cycle costs with zircaloy are appreciably lower than with stainless steel. The difference is greater when uranium is purchased than when leased. However, zircaloy might not have this advantage if thin-walled rather than free-standing cladding were used. (OTS)

17265 (AMF-338-TR-4) AMF ON-POWER REFUELING SYSTEM FOR A CANDU-TYPE REACTOR. PROTOTYPE REFUELING HEAD. Final Developmental Report. (AMF Atomics, York, Pa.). Dec. 1964. Contract AT (38-1)-233. 239p. Dep.(mn); $6.00(cy), 5(mn) CFSTI.

The design, manufacture, and testing of a prototype refueling head for a CANDU-type heavy-water reactor having natural-uranium fuel in bundles of rods are described. The reactor is considered to have 306 identical fuel channels, housing identical fuel elements. The fuel channels are divided into two zones, depending on the neutron-irradiation level. (T.F.H.)

17266 (ANL-6926) THEORETICAL STUDY ON THE TRANSFER FUNCTION OF BORAX-V WITH CENTRAL SUPERHEATER. Jiro Wakabayashi (Argonne National Lab., Idaho Falls, Idaho). Aug. 1964. Contract W-31-109-eng-38. 40p. Dep.; $2.00(cy), 1(mn) CFSTI.

An analytical, overall, reactor transfer function was derived to examine the stability problems of the BORAX-V boiling water reactor having an integral central superheater. Special consideration was given to local pressure and time delay of void formation caused by superheating of the water. For this analysis, the boiling core was divided into inner and outer parts to introduce the effects of the radial flux distribution. Where appropriate, the analyses were individually done for these two boiler regions and the central superheater region, and the feedback effects were combined. Basic assumptions introduced into the analyses are that the flux deviation is proportional to the initial flux; the power generation in the boiler (UO_2 pellets) and the superheater (UO_2 stainless steel cermet) is proportional to the overall reactor flux distribution; i.e., no spatial kinetic effects are considered; and the individual reactivity phenomena (i.e., local temperature and void changes) are first-power flux-weighted to obtain the effective reactivity changes. (auth)

17267 (CEA-R-2466) RESULTATS DES ESSAIS AEROTHERMIQUES EFFECTUES SUR LA GRAPPE EL 4 N° C 5 DANS LA CELLULE A PRESSION ATMOSPHERIQUE. (Aerothermal Test Results Obtained on the EL 4 Cluster No. 5 in the Atmospheric Pressure Cell). Bernard Gasc (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 40p. Dep.(mn).

In the framework of thermal studies on the El-4 cluster, the full-scale tests at atmospheric pressure are designed to permit measurement of local values of the wall temperature, velocity, and temperature in the fluid. The experimental results make it possible to follow the changes in these values along the cluster and to predict in much detail the in-pile thermal behavior. In particular it is shown that changes in the wall temperature along the cluster are greatly influenced by disruption of the flow caused by grids and supports. (auth)

17268 (CONF-654-25) ANISOTROPIC MIGRATION AREA MEASUREMENTS IN A D_2O MODERATED LATTICE OF GAS-COOLED UO_2 ROD CLUSTERS. A. E. Dunklee, W. B. Rogers, and P. A. Lourme (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). [1963]. Contract AT(07-2)-1. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 33rd Symposium on Shock, Vibration and Associated Environments, Washington, D. C., Dec. 1963.

Experiments are described whose purpose is the measurement of the anisotropy in migration area and the magnitude of the migration area in a lattice similar to that proposed for the EL-4 French reactor. (T.F.H.)

17269 (CONF-654-41) PERFORMANCE OF THIN-WALLED STAINLESS-STEEL-CLAD ROD-TYPE FUEL ELEMENTS IN SAXTON. D. R. McClintock, E. Paxson, and H. M. Ferrari (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3269. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Ten thin-walled type 304 stainless steel clad fuel rods were irradiated as part of the Saxton core to a maximum burnup of 8900 Mwd/MTU at a maximum heat flux of 410,000 Btu/hr/ft^2. The corresponding integrated fast flux exposure (>1 Mev) was 1.1×10^{21} nvt. Post-irradiation examinations revealed no evidence of failure or crack formation, although the thin-walled clad was subjected to plastic deformation. The successful operation of this engineering proof test emphasizes the satisfactory performance of stainless steel in a borated pressurized water environment. (auth)

17270 (CVNA-227) CVTR THERMAL-HYDRAULIC DESIGN FOR 65-MW GROSS FISSION POWER. R. O. Sandberg and A. A. Bishop (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1965. Contract [AT(30-1)-2289]. 82p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A thermal and hydraulic analysis was made to investigate the feasibility of increasing the steady state power capabilities of the present CVTR core from 44.3 Mw to 61.7 Mw. As a result of this study, it was concluded that the core can be safely operated at the increased output, including power transients up to 118% overpower, without exceeding thermal-hydraulic design criteria. (auth)

17271 (DLCS-3430106) PERIODIC CALIBRATION OF REACTOR PLANT INSTRUMENTATION (PRESSURE, FLOW, LEVEL AND DIFFERENTIAL PRESSURE). CORE 1, SEED 4. Test Evaluation. (Duquesne Light Co., Shippingport, Pa.). First issue, May 22, 1964. Second issue, July 31, 1964. Contract AT(11-1)-292. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The reactor plant pressure, flow, level, and differential pressure instrumentation associated with the reactor coolant system, pressurizer and pressure relief system, and coolant purification system, is calibrated periodically to determine and correct any calibration drift. The subject instrumentation was calibrated during Core 1–Seed 4 lifetime and the calibration drift observed was considered to be negligible. The required calibration accuracy could not be met in all calibrations; however, all calibrations were considered acceptable for plant operation since the instrumentation was accurate in the normal operating range. Some modifications and component replacements were performed during Seed 4 lifetime to improve the accuracy and simplify calibration of the instrumentation. (auth)

17272 (DLCS-5001164) MONTHLY OPERATING REPORT [ON PWR OPERATIONS], NOVEMBER 1964. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The Shippingport Atomic Power Station remained shutdown throughout November for modification of the Reactor Plant for Core 2 operation. The new boilers were initially filled during the month for coid lay-up and then drained when it was observed that the boiler supports were becoming distorted and a support weld had failed. Other items of significance are summarized in operations, maintenance, test and the training programs, health physics, and the overall refueling operation. (auth)

17273 (DPST-64-83-12) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, DECEMBER 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Jan. 22, 1965. Contract AT(07-2)-1. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effect of rod spacing on heat transfer burnout in heavy-water-moderated power reactors cooled by boiling light water was investigated. Physics experiments with fuel assemblies simulating burned-up fuel and hydride orientation and mechanical properties of thin-walled Zircaloy tubing are discussed. (C.E.S.)

17274 (EURAEC-1250) HYDRODYNAMIC INSTABILITY LIMITING THE POWER OF BOILING WATER REACTORS. Quarterly Report No. 2, April 1–June 30, 1964. (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). July 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contracts 006-64-1-TEEF and 6435 R. 84p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Studies were devoted to the "density effect" model. After the equations were rewritten to include unheated lengths and "subcooling," dimensional analysis was found useful to reduce from 12 to 6 the number of independent parameters governing the model. Dimensional equations are presented for each region and, after some calculations, the number of useful unknown functions is reduced from 4 to 2 (inlet velocity/density). An important role is played by the inlet velocity. The system cannot be solved analytically. (auth)

17275 (EURAEC-1272) HYDRODYNAMIC INSTABILITY LIMITING THE POWER OF BOILING WATER REACTORS. Quarterly Report No. 3, July 1–September 30, 1964. (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). Nov. 5, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contracts 006-64-1-TEEF and 6435 R. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Starting from the adimensional system, studies were made for the steady-state regime and for small disturbances in the neighborhood of the steady-state regime. As far as the former regime is concerned, it is shown that the six parameters of the model are not allowed to have any value. This is a result of the dynamic condition (constant pressure drop between inlet and exit). The drawing of the surface limiting the possible domain is easy in each particular case. Small disturbances of the form $v = v_0 e^{ct}$ are studied. A characteristic equation was obtained for C. For the instability thresholds, this characteristic equation leads to a system of two equations, containing the pulsation ω as a parameter. This system defines the threshold surface. (auth)

17276 (GEAP-4702) SPECIFICATION OF SENN ON-LINE COMPUTER SYSTEM AND THERMAL-HYDRAULIC CALCULATIONAL FUNCTIONS. T. Sorlie (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.) Nov. 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 153p. (EURAEC-1313). Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The specification of a data logging and computer system for the Garigliano Nuclear Power Station is studied. The system input, output, and computational functions are defined, and the equations defining the computational functions are derived and presented. The computer functions are divided into two categories, the periodic and the on-demand functions. Three calculational periods are defined, namely hourly, daily, and monthly. Ten on-demand calculational programs have been specified for the computer system. These programs are designed to calculate, and present through printout, extensive information on details of

current and cumulative reactor and plant operation. The execution of on-demand programs are requested by the operating personnel through an on-demand console. (auth)

17277 (IDO-11401(p.1-8)) THE ORGANIC REACTOR CONCEPT. Charles A. Trilling (Atomics International, Canoga Park, Calif.).

The characteristics of organic coolants and moderators are discussed, and their advantages are outlined. The advantages of organic cooling of heavy-water-moderated power reactors are also given. The principal development requirements of organic coolants are described, and the history of various research and development programs is given. A brief account is given of OMRE and PNPF operation experience. (D.L.C.)

17278 (IDO-11401(p.261-354)) FILM FORMATION ON HEAT TRANSFER SURFACES. Ralph J. Sullivan and Robert T. Keen (Atomics International, Canoga Park, Calif.).

The formation of fouling films in the OMRE and its mechanism were studied. The operation of OMRE Cores I and II is described, and the appearances of the fouled fuel elements are described. Tests which were performed during Core III operation to study the fouling mechanism are discussed. It is concluded that control of coolant quality can reduce the fouling rate to less than 1 mil/yr. Some in-pile loop studies are also described, and the fouling mechanism is considered in detail. The effects of impurities and other experimental parameters of fouling rates are discussed. Control of fouling by various methods is considered. (D.L.C.)

17279 (NAA-SR-10531) MULTIGROUP CALCULATION METHOD WITH APPLICATION TO THE SGR CRITICAL EXPERIMENT. F. L. Fillmore (Atomics International, Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 66p. Dep.; $3.00(cy), 2(mn) CFSTI.

The primary purpose of the studies presented is to examine the adequacy of methods for treating certain features of multigroup calculations in graphite moderated lattices. The features of most concern are: thermal neutron spectrum effects arising from the separation of fuel and moderator, resonance capture and fission, and fast fission. Methods which are applicable to homogeneous or nearly homogeneous systems find extensive use in practice. These methods are included in this survey in order to assess their reliability and to obtain results with them which can be compared with results obtained from other more complex procedures which are more appropriate for lattices. The calculations are made for a set of critical assemblies so that experimental results are also available for comparison. An additional purpose is to present a reasonably detailed description of the multigroup methods being considered and to indicate points where improvements appear to be warranted. Although certain improvements may be difficult to implement, a better understanding of the specific problem areas cannot help but contribute to progress. It appears that one of the most significant deficiencies in methods which employ a homogeneous model in treating non-thermal groups is a large error in the treatment of fast fission. The defect in reactivity is about 4% for the lattices considered. This can be partially corrected by means of a diffusion theory cell calculation, but transport theory is needed in order to obtain good results. Another deficiency is encountered in methods which homogenize the fuel and moderator in the calculation of the thermal neutron spectrum. It was found that some of the homogenizing methods examined introduced in some cases errors of more than 2% in calculated reactivities. This error is of opposite sign to that of fast fission. Shortcomings in the treatment of resonance capture and fission were not found to contribute large errors in the lattices studied. This is reasonable because all of these lattices are well thermalized. Reactivity values obtained with a flux-weighted multigroup procedure are in good agreement with measurements. (auth)

17280 (NP-14703) OTDEL'NYE VOPROSY KONSTRUIROVANIYA UZLOV OSADITEL'NYKH DATCHIKOV DLYA SISTEMY KGO. (Certain Problems in Designing Precipitation Detector Units for Burst-Cartridge Detection Systems (Review)). G. K. Ermakov, V. I. Polikarpov, A. M. Radyvanyuk, and E. A. Tamanov (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. 17p. Dep.(mn).

A review is given of the design and construction of precipitation units for burst-cartridge detection based on krypton and xenon decay product detection. Descriptions are given of the scheme of the French and English precipitation detector units used with heterogeneous gas-cooled reactors and precipitation detector units used with water-cooled reactors in Sweden and England. (R.V.J.)

17281 (ORNL-3690) PHOTOELASTIC ANALYSIS OF EGCR PRESSURE VESSEL. J. E. Smith (Oak Ridge National Lab., Tenn.), C. C. Wilson (Tennessee Univ., Knoxville), and W. F. Swinson (Auburn Univ., Ala.). Feb. 1965. Contract W-7405-eng-26. 44p. Dep.; $2.00(cy), 2(mn) CFSTI.

A three-dimensional photoelastic stress analysis of the top head of the Experimental Gas-Cooled Reactor (EGCR) pressure vessel was made to amplify and augment information obtained from a study of a strain-gaged model and to provide additional information regarding the stresses and stress distributions. The results verified the adequacy of the structural design and, in general, agreed with the results of the strain-gage analysis. The photoelastic model had a scale factor of 1/14.2 and was fabricated from Bakelite ERL-2774 epoxy resin. The fabrication procedures, the methods for loading, and the procedure for freezing stresses in the model are described. Both internal pressure and an axial load were imposed on one nozzle. Procedures used for data collection and reduction are discussed. The stress distributions given are for the spherical head in regions between the cluster nozzles and adjacent to the gas-outlet and burst-slug-detection nozzles. Stresses in the cylindrical portion of the pressure vessel and in the transition region between the head and shell are also given. The only nozzle stresses shown are for the gas-outlet and burst-slug-detection nozzles. All stress distributions are presented graphically. The isoclinic lines in the nozzle-to-shell attachment region for a nonradially attached (hillside) nozzle were obtained. A comprehensive discussion of all results is given, along with a description of the methods used in correcting for data distortion due to surface effects. (auth)

17282 (WCAP-5496) MEASUREMENT OF LOCAL KINETIC PARAMETERS IN THE SAXTON REACTOR. V. Rajagopal and G. E. Swen (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3269. 25p. (CONF-650406-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Neutron Dynamics and Control, Tucson, Ariz.

Experimental measurements of local transfer functions were performed in the Saxton experimental power reactor using a movable in-core neutron detector with a view to determine local kinetic parameters such as prompt power coefficient of reactivity and fuel time constant. The measurements consisted of perturbing the core reactivity through a reactivity modulator in a pseudo-random manner and measuring the response signal from an in-core detector at various locations. The input and response signals were recorded on magnetic tape and processed in a cross-power spectrum analyzer to determine the transfer functions. The experimental data were processed in a digital computer and fitted to a mathematical model in a least square sense to yield local kinetic parameters. Applications and the usefulness of such techniques in obtaining information on local kinetic behavior of a power reactor are discussed. (auth)

17283 (WCAP-6070) YANKEE CORE EVALUATION PROGRAM QUARTERLY PROGRESS REPORT FOR THE

PERIOD ENDING DECEMBER 31, 1964. M. J. O'Boyle, comp. and ed. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1965. Contract AT(30-1)-3017. 117p. Dep.; $4.00(cy), 3(mn) CFSTI.

Scheduled fuel examinations have been completed. In-cell equipment used to examine, section, and test fuel rods has been removed from the hot cells, decontaminated, and stored for future use. Control rod work was initiated. Six metallurgical samples and four tensile test specimens were prepared. The evaluation of the control rod metallographs was begun. Studies of the effects of non-asymptotic spectra on nuclear parameters and the plutonium composition were completed. A detailed analysis of the nuclear factors that influence the value of moderator temperature coefficient during core lifetime was completed. (auth)

17284 (ORNL-tr-405) MODEL TECHNIQUE IN THE DESIGN OF A NUCLEAR POWER PLANT. Stanislav Kittrich. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 15-17(1964). 10p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

Engineering techniques for the purpose of improving the economics of nuclear-power-plant design are outlined. (T.F.H.)

17285 FUEL ELEMENTS FOR NUCLEAR SUPERHEAT. R. Schwarzwaelder (Allgemeine Elektrizitatsgesellschaft, Frankfurt am Main). Atomkernenergie, 9: 385-94(Nov.-Dec. 1964). (In German)

A survey is given of the different fuel elements being considered at the present time for nuclear superheat. The possible alternatives are considered either from the fuel, or from the cladding material or from the geometry and method of functioning of the elements. Then follows a summary of the main problems with superheat elements, i.e., the corrosion and erosion, the mechanical integrity of superheat elements at high temperatures and under irradiation, and a reasonable and simple design. The concept of the AEG superheat reactor is discussed under special consideration of the fuel elements. The fuel elements for the AEG superheat reactor are tubular combined boiling and superheating fuel elements. A short survey of the most important development efforts for these fuel elements is given. Some results of out- and inpile tests with superheat fuel elements are reported. Besides in outpile tests combined boiling and superheating fuel element tubes were subjected up to now to more than 800 severe thermal cycles in a thermocycling facility, without any damages having occurred at these fuel elements. In a test loop for testing superheat fuel elements in the Kahl Nuclear Power Station different superheat fuel elements were inserted since December 1963. No defects were noticed up to now. (auth)

17286 ANALYSIS OF THE LOSS OF EXERGY RESULTING FROM THE REACTOR HEAT TRANSFER. Hans-Georg Paul (Technische Hochschule, Hanover). Atomkernenergie, 9: 411-15(Nov.-Dec. 1964). (In German)

The losses of exergy resulting from the heat transfer from the fuel elements to the coolant are analyzed. The reasons for these losses are: coolant flows at different temperatures mixing at the outlet of the core, temperature differences between coolant and canning, and the drop in coolant pressure. (auth)

17287 CALCULATION OF THE MOST FAVORABLE COOLANT DESIGN VALUES OF TWO CYCLE NUCLEAR POWER PLANTS USING EXERGETICAL DEGREES OF QUALITY. Hans-Georg Paul (Technische Hochschule, Hanover). Atomkernenergie, 9: 417-24(Nov.-Dec. 1964). (In German)

A description is given of how to calculate the most favorable coolant design values for two cycle nuclear power plants. They are most favorable if the exergetical degree of quality of heat transfer from the reactor to the coolant achieved is maximum value or if the losses of exergy resulting from the heat transfer have their lowest amount. (auth)

17288 GENERATION OF ELECTRICAL ENERGY BY NUCLEAR MEANS. Manuel Telleria Marques. Bol. Junta Control Energia At. (Peru), 9: No. 49, 53-66(Apr.-June 1964). (In Spanish)

The need for energy sources other than coal is discussed by citing the statistics available on the present consumption and world reserves. The evolution of energy consumption is indicated. The development of nuclear reactors to the stage where they are economically competitive with other energy sources is then considered. The costs of nuclear energy production are summarized from data available on nuclear power plants now in operation. The commercial development of nuclear power plants by private companies is indicated by reference to the development program of the Pacific Gas and Electric Co. (J.S.R.)

17289 THE COST PRICE OF THE NUCLEAR KILOWATT-HOUR. Bull. Inform. Assoc. Belge Develop. Pacifiques Energie At., 9: No. 51, 7-15(Aug. 1964). (In French)

The most recent data available to Euratom on the cost price of the nuclear kilowatt-hour were examined at a Symposium at Venice on Oct. 29-31, 1963. The principal topics discussed were the methodology of the calculation of the cost price, cost price of energy produced by nuclear power plants in the Community, Community participation program, and in the EDF and SELNI power plants, analysis of the construction contracts of power plants under development, consumption and production of fissionable material in tested reactors, and future prospects of the cost price in power plants equipped with tested reactors. The data from these discussions were summarized. (J.S.R.)

17290 SOME ASPECTS OF THE DYNAMIC BEHAVIOR OF FORCED-CIRCULATION STEAM-GENERATING PRESSURE-TUBE REACTORS. J. B. van Erp (Euratom, Brussels) and G. Possa. Energia Nucl. (Milan), 12: 61-76(Feb. 1965).

A comparison is made between the dynamic characteristics of the early group of pressure-vessel boiling-water reactors and the more recent group of pressure-tube steam-generating reactors. It is noted that, among others, due to decreased values of the coolant transit-time in the core, the influence of the two-phase flow dynamics is smaller for the latter group than for the former. The fact that pressure-tube steam-generating reactors tend to have a positive void coefficient of reactivity brings about certain dynamic characteristics, which have a strong bearing on the overall design. The conditions for inherent stability (overall and spatially; with and without pressure feedback) are discussed. The possibility of self-regulation in the case of positive void coefficient of reactivity, without the need of introducing a dual-cycle system, is indicated. (auth)

17291 THE FAST NEUTRON REACTOR SYSTEM. A. Ertaud. Energie Nucl., 6: 417-26(Nov. 1964). (In French)

The efficiency of the fast reactor system with respect to the use of natural uranium and the plutonium produced by thermal reactors is discussed, with consideration of breeding, fuel systems, technology, economics, and the development of fast reactors. (D.C.W.)

17292 SOME PRESENT DAY ECONOMIC ASPECTS OF NUCLEAR ENERGY. J. Gaussens (Commissariat a l'Energie Atomique, [Paris]). Energie Nucl., 6: 427-31 (Nov. 1964). (In French)

The bases for the decision to develop in France power reactors using natural uranium are discussed, including power needs and supplies, the cost of the fuel, and the stability of the fuel supply. The capital, fuel, and power costs of some European power plants using different reactors are compared, showing a considerable advantage for the graphite-natural uranium reactor EDF-3. (D.C.W.)

17293 ON THE SCHEDULE OF CONSTRUCTION FOR THE TOKAI NUCLEAR POWER PLANT. Masami Ushikubo (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 29, 304-8(Dec. 1963). (In Japanese)

The scheduling, the philosophy of management, and the problems encountered in the construction of Tokai Power

Plant are described. The construction of the plant includes eight phases: (1) installation of the foundation, (2) construction of the basement, (3) installation of the inner shielding, (4) construction of the reactor pressure vessel, (5) installation of the top shielding and construction of the building for fuel handling, (6) installation of equipment in the pressure vessel, (7) pre-commissioning, and (8) commissioning. During these phases of construction, several works require adjustment of the schedule. These adjustments are described. The schedule is sometimes influenced by unknown factors such as installation of gas ducts or a crane or delay in arrival of the equipment. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17294 ANALYSIS OF THE CONSTRUCTION PLANS FOR THE TOKAI ATOMIC POWER PLANT. Yasuichi Shimizu (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 30, 373-7(Feb. 1964). (In Japanese)

The design and the supervision of construction of the Tokai Atomic Power Plant (JAPCO) were done by English engineers. This analysis of the construction plan is made at the time when the over-all construction of the atomic plant is 95% finished. It is intended for the use in the construction of similar atomic power plants. Of the many buildings involved, the reactor building is discussed particularly. The various items of construction cost are calculated and tabulated. The ratio of the cost of structural work to that of finishing work is 7:3 for the reactor building; the ratio for business buildings is about 1:1. In order to show the problems in the construction plan, the reactor building is divided into ten sections according to function, and detailed analyses are made using the floor plans and elevations. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17295 JAPAN POWER DEMONSTRATION REACTOR. Kaneyoshi Kubushiro (Japan Atomic Energy Research Inst., Tokyo) and Kunio Hamada. Genshiryoku Hatsuden, 7: No. 3, 1-35(Sept. 1963). (In Japanese)

The JPDR, the first reactor to generate electricity by atomic energy in Japan, is described. In 1960 a contract was made for the construction, in 1961 construction was started, in 1962 the reactor proper and its auxiliary facilities were installed, and in October 1963 the first electricity by atomic energy was produced. The purpose of the JPDR is to provide operation experience for light-water power reactors and to obtain the basic data for the development of power reactors. These basic data include reactor safety, reliability, and economy of atomic power generation. The contractor was the GEJ. The U.S.A. and various makers in the U.S.A., including GE, provided the major components of the plant. In Japan, the Hitachi, Ltd., the NAIG, etc., worked as sub-contractors. The Hitachi, Ltd., made the pressure vessel, the waste disposal facilities, etc., and the NAIG the instruments, part of the fuel handling equipment, the reactor housing building, etc. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

17296 THERMAL STRESS ANALYSIS FOR REACTOR PRESSURE VESSEL NOZZLES. Kunio Kamada (Kitachi Ltd., Tokyo). Hitachi Hyoron, 45: No. 12, 91-4(Dec. 1963). (In Japanese)

In recent years, the tendency has become greater to ensure the safety of a reactor pressure vessel by well-balanced design instead of introducing the safety-factor concept. In order to obtain such well-balanced designs, a thermal stress analysis must be made on the nozzles. With the pressure vessel of the Japan Power Demonstration Reactor as an actual example, the method of analysis is given. For the complicated part of the vessel, at the transient state a three-dimensional temperature distribution is obtained by digital computers. The TRTM-3 cord (Hitachi) and TIGER cord (GE) are used for the IBM-7074 and Philco-2000, respectively. The nozzle is assumed to be composed of three parts: a spherical shell, a ring, and a cylindrical shell. The composite thermal stress for the nozzle is obtained by the summation of the thermal stresses for the individual parts, based on the temperature distribution and the stresses due to the discontinuous force induced on the joints. Lastly, the differences in thermal stress between the parts should be compared with the allowable stress. For the JPDR, it was concluded that 60000 cycles of normal startup and shutdown or 2400 cycles of emergency cooling would be possible for the most fragile nozzle of the JPDR pressure vessel. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17297 EXPERIENCE WITH CANADA'S FIRST NUCLEAR POWER STATION (NPD) AND THE PROSPECTS FOR HEAVY WATER POWER REACTORS. W. B. Lewis (Atomic Energy of Canada Ltd., [Ottawa]). J. Brit. Nucl. Energy Soc., 3: 162-72(July 1964).

Some working experience and changes therefrom for the NPD station are reported. Uranium futures along with the future of heavy water power reactors are discussed. (R.E.U.)

17298 STUDIES TO DETERMINE THE SAFETY MARGINS AVAILABLE ON MAGNOX-TYPE GAS-COOLED REACTORS IN A DEPRESSURIZATION ACCIDENT. 1. BASIC TRANSIENT FLOW STUDIES IN STAGE I REACTOR MODELS. J. G. Moore (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.) and F. J. Walford. J. Brit. Nucl. Energy Soc., 3: 174-85(July 1964).

A theory developed to predict pressure transients in a typical gas-cooled reactor system, which is depressurizing rapidly (within seconds), was tested against experimental results and the agreement is satisfactory. (auth)

17299 STUDIES TO DETERMINE THE SAFETY MARGINS AVAILABLE ON MAGNOX-TYPE GAS-COOLED REACTORS IN A DEPRESSURIZATION ACCIDENT. 2. CORE FLOW TRANSIENTS FOLLOWING CIRCUIT LEAKAGE: ESTIMATION OF LONGEST CORE STAGNATION TIME AND STUDY OF THE EFFECTS OF DUCT FRICTION AND POSITION AND SIZE OF FRACTURE. W. A. J. Wall (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Brit. Nucl. Energy Soc., 3: 186-97(July 1964).

Leakage of gas from a reactor will cause redistribution of the circuit flows, and under certain conditions of discharge small core flows would result. Considering the fracture of a duct of a reactor within which a constant temperature distribution is maintained, a simple method is presented for the calculation of the longest period of time for which near zero core flow can occur, and conjointly the effective fracture area to produce this state is also found. Zero core flow during the depressurization transient leads to peak fuel temperatures, but improvements to cooling are gained by small deviations from the critical discharge area. (auth)

17300 STUDIES TO DETERMINE THE SAFETY MARGINS AVAILABLE ON MAGNOX-TYPE GAS-COOLED REACTORS IN A DEPRESSURIZATION ACCIDENT. 3. APPLICATION OF THE SAFETY LIMITATION AGAINST DEPRESSURIZATION TO THE CALDER AND CHAPELCROSS REACTORS. H. A. Hughes (United Kingdom Atomic Energy Authority, Windscale, Sellafield, Eng.) and R. M. Horsley. J. Brit. Nucl. Energy Soc., 3: 198-203(July 1964).

The calculated temperature rise following a fault in the pressure vessel giving depressurization is incorporated in the fuel element temperature control criterion used on the Calder and Chapelcross reactors. The basis of this criterion and its practical application to reactor control are described. (auth)

17301 STUDIES TO DETERMINE THE SAFETY MARGINS AVAILABLE ON MAGNOX-TYPE GAS-COOLED REACTORS IN A DEPRESSURIZATION ACCIDENT. 4. STUDIES OF TEMPERATURE TRANSIENTS IN CALDER AND CHAPELCROSS REACTORS FOLLOWING ASSUMED DEPRESSURIZATION. B. Wilson (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.) and R. Dodds. J. Brit. Nucl. Energy Soc., 3: 204-10(July 1964).

In order to specify permissible operating temperatures for fuel elements in a magnox reactor, a knowledge is required of the transient suffered in the worst credible fault. Because of safety and technical considerations the information obtained from direct experiment is both limited and costly. Theoretical predictions are therefore necessary,

moreover the complexity of the problem almost demands computer study. However, such studies in addition to providing the required answer (usually based on pessimistic assumptions) demonstrate the relative importance of uncertainties in items of input data and indicate those areas in which judicious (and perhaps indirect) experiment might be profitable. (auth)

17302 STUDIES TO DETERMINE THE SAFETY MARGINS AVAILABLE ON MAGNOX-TYPE GAS-COOLED REACTORS IN A DEPRESSURIZATION ACCIDENT. 5. CHANCE OF A CHANNEL FIRE IMMEDIATELY FOLLOWING DEPRESSURIZATION OF A STAGE I REACTOR. F. M. Leslie and F. B. Boardman (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Brit. Nucl. Energy Soc., 3: 211-13(July 1964).

Consideration is given to the extension of the probability approach as applied to the primary transient following a circuit breach on a Stage 1 reactor. It is shown that a considerable factor of pessimism can be introduced by taking parameters with "e[illegible]ne" or "boundary" values. The suggestion is made th[illegible] Stage 1 reactors be operated in such a way that there is a 0.1 probability for a channel fire using mean parameter values with associated random errors and assigning equal probability to the size of fracture. (auth)

17303 ANNEALING AND PNEUMATIC TEST MADE ON THE PRESSURE VESSEL OF THE NUCLEAR REACTOR OF THE TOKAI POWER STATION. Akio Nomura and Masaaki Ono (Japan Atomic Power Co.). Karyoku Hatsuden, 15: 297-304(Apr. 1964). (In Japanese)

The pressure vessel of the Tokai reactor was subjected to post-welding annealing in June 1963 and to a pneumatic pressure test in January 1964. Electric current was used as the heating source for corrosion and temperature control. Annealing was done to remove the residual stresses due to the welding. For heating the vessel, nickel-chromium bands were used inside the vessel and the latter was covered with rock-wool insulator. The temperature distribution in the vessel was better than anticipated; it was within 20–25°C at the most. The distortions of the vessel after annealing were found to be only a few mm. at the top, and about 5 mm. at the side. After annealing, the vessel was grid blasted to remove the scales and oils adhering on the surface. In the pressure test, air was blown into the vessel, using air compressors; the required maximum stress at 25 kg/cm^2 was attained. (NSA of Japan)

17304 GAS-COOLED HIGH-TEMPERATURE THERMAL REACTORS. D. Tytgat and M. de Bacci. Neue Tech., 6: 266-72(Oct. 1964). (In French)

The principal characteristics of high-temperature gas-cooled reactors are presented. Because of their high power density, excellent neutron economy, very compact heat exchangers, and advanced turbines, these reactors can possibly lead to power plants having investment costs comparable to light-water power plants and fuel costs comparable to natural uranium reactors. (J.S.R.)

17305 DRAGON. Nucl. Eng., 9: 425-32(Dec. 1964).

Design and construction of the Dragon reactor, a high-temperature (750°C) gas-cooled homogeneous power reactor, is reviewed. Diagrams are given of the reactor building, cross section through the reactor, and schematic coolant flow. Fabrication and testing of the pressure vessel, core support structure, ^{235}U-ThC$_2$ and ^{235}U-ZrC fuel pellets, graphite reflector and fuel coating, BC absorber control rods, He coolant system, fuel handling system, purge system, and He purification system are discussed. (M.J.T.)

17306 GAS SAMPLING AND ANALYSIS SYSTEM. H. F. Enzmann. Nucl. Eng., 9: 433-4(Dec. 1964).

The system for sampling and analytical monitoring to control the purity of the He coolant in the Dragon reactor is described. The selection of sampling points and the use of sampling lines permanently connected to remotely operated analytical instruments are discussed. Problems in the detection of impurity levels barely higher than the instrument sensitivity threshold are mentioned. (M.J.T.)

17307 37-WAY SELECTOR VALVE. E. J. Mitchell and C. Harper. Nucl. Eng., 9: 435-6(Dec. 1964).

The Dragon core contains 37 fuel element assemblies mounted on hollow spikes through which fission products released from the fuel are continuously removed by a purge flow of He. The 37-way selector valve was designed to communicate individual purge flows to systems for detection and location of faulty fuel elements and for radiochemical analysis of the purge gas. Main requirements for the selector are given. Choice of the basic design, special problems, and prototype testing are described. (M.J.T.)

17308 REMOTE CUTTING AND WELDING TECHNIQUES. A. R. Bateman and E. Barnes. Nucl. Eng., 9: 437-8(Dec. 1964).

A method was developed for remotely welding valves into the stainless steel circuit and for remotely removing and replacing such valves using shielded equipment, for the Dragon reactor. The development and testing of prototype equipment is described. The valve design is illustrated, and details of welding and the welding equipment are considered. The process of remote handling of valves is described. Problems encountered, such as hot cracking in the welds and splitting of the W electrodes, are summarized. (M.J.T.)

17309 NUCLEAR POWER IN THE UNITED KINGDOM. C. P. Haigh. Nucl. News, 8: No. 1, 13-18(Jan. 1965).

The role of the Central Electricity Generating Board in supplying electricity in the United Kingdom and in nuclear-power research and development is surveyed. Various areas of research at the Berkeley Laboratory — materials research (graphite chemistry, for example), engineering research, physics studies, and health physics — are reviewed. Future joint development of a fast power reactor by the CEGB and the UKAEA is considered. (M.J.T.)

17310 THE ADVANCED EPITHERMAL THORIUM REACTOR (AETR) CRITICAL EXPERIMENTS. L. A. Mountford and H. A. Morewitz (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 21: 421-8(Apr. 1965).

Multiregion critical cores, built on a split-table assembly machine, were used to investigate reactor compositions typical of epithermal and fast power reactors. The design and operating features of the facility, constructed to study the Th–^{233}U fuel cycle, are described. Criticality calculations were in good agreement with experimental values. (auth)

17311 REACTIVITY MEASUREMENTS IN THE ADVANCED EPITHERMAL THORIUM REACTOR (AETR) CRITICAL EXPERIMENTS. S. G. Carpenter (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 21: 429-40(Apr. 1965).

Reactivity effects of various materials of interest to epithermal and fast reactors were measured in a series of neutron spectra with median energies of neutrons causing fission ranging from 422 kev to 8.5 ev. An oscillator technique capable of sensitivities of 10^{-8} Δk was used. In addition, a power-history or reactivity-vs-time method was developed for fast, but less sensitive reactivity measurements. It was used to obtain radial reactivity traverses and rod calibrations and for other routine reactivity measurements. (auth)

17312 FISSION-RATE MEASUREMENTS IN THE ADVANCED EPITHERMAL THORIUM REACTOR (AETR) CRITICAL EXPERIMENTS. Donald Strominger and Gordon Schlesinger (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 21: 441-50(Apr. 1965).

Solid-state p-n junction counters were fabricated to measure fission rates of materials with different fission thresholds. The fission reactions are caused by neutrons varying in energy from thermal energies for ^{235}U to 1.5 Mev for ^{232}Th. The data gathered from these solid-state fission counters were used to compare experimental with calcu-

lated fission rates in the AETR cores. The fission counter is assembled by placing an electroplated foil of a fissionable material near a p-n junction detector. An aluminum cap is placed over each detector and foil to form a neat, compact assembly. The resulting counter is small enough to fit inside a reactor with minimum distortion to the neutron spectrum. Fission counters employing ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, and ^{239}Pu as the principal fissionable material were successfully fabricated. These solid-state fission counters have proved reliable instruments to measure neutron fluxes in high gamma fields. True fission events are easily separated from other induced reactions in the counter. (auth)

17313 NEUTRON-IMPORTANCE MEASUREMENTS IN THE ADVANCED EPITHERMAL THORIUM REACTOR (AETR) CRITICAL EXPERIMENTS. Robert J. Tuttle (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 21: 451-62(Apr. 1965).

The variation of neutron importance with energy and position was investigated in a multiregion critical assembly having a series of test regions typical of slightly epithermal to fast power reactors. Values of neutron importance at the center of the test regions were measured using neutron sources and a reactivity oscillator. The variation of neutron importance with position was determined using neutron sources in conjunction with a dynamic reactivity measurement technique. Analysis of data from similar beryllium- and carbon-moderated test regions indicates the significance of the Be(n,2n) reaction. The neutron sources used were Po–Be, Po–^{11}B, Po–CaF_2, Po–^{7}Li, Mock Fission and Sb–Be. Published source spectra were used in the analysis of the data; the Mock-Fission-source spectrum was determined by gamma spectroscopy. Relative yields of these sources were determined by calibration in a manganese sulfate bath. (auth)

17314 CONCEPTUAL DESIGN OF A PRESTRESSED CONCRETE REACTOR PRESSURE VESSEL. Chen Pang Tan (Univ. of Pennsylvania, Philadelphia). Nucl. Struct. Eng., 1: 224-31(Feb. 1965).

A conceptual design for a horizontal cylindrical prestressed-concrete reactor pressure vessel for housing a large gas-cooled high-power-density reactor and power generating equipment is presented. The evolution of the geometry of the vessel design is described. Structural considerations for a full chamber-size opening are outlined. The choice of tendons and anchorages is discussed. Consideration is given to the practical aspects of construction. (auth)

17315 ASEISMIC DESIGN AND DYNAMIC ANALYSIS OF NUCLEAR POWER PLANTS. PART I. SWAYING MOTION. K. Akino and H. Tajimi. Nucl. Struct. Eng., 1: 232-8(Feb. 1965).

Some problems in the aseismatic design for nuclear power plants are surveyed, and a proposed method of solution by dynamic analysis is illustrated with examples of the first Japanese power reactor JPDR (Japan Power Demonstration Reactor). Two major buildings of the JPDR represent different types of vibration mode. The square turbine building on the surface sand and concrete pile foundation was analyzed as a swaying-motion structure, and the cylindrical containment vessel supported on the sandy shale was treated as a rocking-motion structure. Gages were mounted in the containment vessel to measure the vibrational behavior caused by natural earthquakes for comparison with this calculation. Data so far obtained showed fairly good agreement between the analysis and measurements. The case of the structure with swaying motion is considered in detail. (auth)

17316 SHAFT-SEAL SYSTEMS FOR LARGE POWER-REACTOR PUMPS. John G. Williams (Worthington Corp., Harrison, N. J.). Nucleonics, 23: No. 2, 49-53, 87(Feb. 1965).

Shaft-sealed pumps for power reactors are described, which are 10 to 15% more efficient and ~40% less expensive than canned pumps. Conditions of service for shaft-sealed pumps are listed, and the current status of high-pressure shaft-seal designs is outlined. Typical leakage rates for shaft-sealed pumps are given. The effects of pump design, hydraulics, shaft diameter, heat baffle, water-lubricated bearing, and coupling on seal system performance are described. The factory test problem is discussed. A survey of shaft-sealed main pumps for large water-cooled reactors is presented. (M.C.G.)

17317 YANKEE INSPECTION. John Kenton. Nucleonics, 23: No. 2, 62-3(Feb. 1965).

International safeguards inspection of the Yankee Power Reactor is described. Procedures are outlined. (M.C.G.)

17318 TOWARD THE OPTIMIZATION OF A NUCLEAR BOILER. P. K. McPherson (Atomic Energy Establishment, Winfrith, Dorset, Eng.). Trans. Inst. Chem. Engrs. (London), 42: T352-60(1964).

Process optimization can be seen as the optimization of process dynamics rather than the design of an optimal control system. Dynamic optimization was found to be possible where the inherent dynamic interactions within a plant can be constrained by the design of the physical elements of the plant to give any desired stability and load following characteristic. It is shown that optimization of this nature might be possible with a certain type of nuclear boiler. (auth)

17319 THE LARGE-SCALE NUCLEAR POWER PLANT AT LINGEN. Herbert Juettemann. VDI (Ver. Deutr. Ingr.) Z., 107: 44-5(Jan. 1965). (In German)

About 70 km north of Muenster, Westphalia, the Lingen nuclear power plant with an electric output of 250 Mw will be erected. It comprises a boiling water reactor producing 160 MW(e). The primary steam produced in the reactor allows for saturated secondary steam being produced in a steam transformer which is led to an oil or natural gas fired superheater and raised there to a temperature of 530°C. The share of the superheater in the electric output reaches 90 Mw. (auth)

17320 TABULATION OF PARAMETERS RELEVANT TO SAFETY FOR A NUMBER OF POWER REACTORS. p.709-33 of "The Technology of Nuclear Reactor Safety. Vol. 1." M.I.T. Press, Cambridge, 1964.

Tables are presented consisting of general descriptions, nuclear parameters, reactivity inventories, and control characteristics of selected power reactors of the pressurized-water, boiling-water, gas-cooled, sodium-cooled, pressure-tube, and other types. (T.F.H.)

17321 CONTROL ROD STUDIES FOR THE ZENITH REACTOR. B. Micheelsen (Atomic Energy Establishment, Winfrith, Dorset, Eng.). p.107-39 of STI/PUB/81.

The k_{eff}, defined by the experimental procedure, is compared with the theoretical value of k_{eff}^{T}, defined by calculation. It is shown that it is normally difficult to give any relation between measured and calculated values of k_{eff}, except when $k_{eff} \simeq 1$. However, the calculations indicate that an experimental procedure with poisoning by a resonance absorber leads to agreement between the two definitions for this reactor type. As the k_{eff} is measured mainly by this method for the second loading of the Zenith reactor, this justifies the comparison of measured and calculated k_{eff}, for both the unrodded and rodded reactor. A short description of the standardized methods of calculating spectra, cross sections for the various reactor regions, and extrapolation lengths of the control rods are given. The effect of the geometrical representation of the core and the control-rod system is investigated, and it is shown how essential it is to take into account the flux variation parallel to the reactor axis. The effect of the spectrum change in the reactor produced when the control rods are inserted is also studied. As a result of these investigations, the discrepancy between experimental and calculated control-rod effectiveness is removed. (auth)

17322 METHODS OF CONTROL-ROD CALIBRATION IN THE WINDSCALE ADVANCED GAS-COOLED REACTOR. D. Smith, J. M. Butterfield, and G. Thorpe (United

Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.). p.203-26 of STI/PUB/81.

Different techniques were used to calibrate control rods and to measure individual rod worths during the commissioning of the WAGR. The methods described are: air poisoning—changes in air pressure allow axial movement of rods at the critical condition, so rod movement can be related to pressure variation, which is equivalent to a reactivity change, rod slope measurements can be made for different rod insertions; rod slopes—the rods are withdrawn to make the reactor supercritical, then later they are inserted to make the reactor subcritical, so that from a measurement of the doubling and having times the change in reactivity between the super- and subcritical states can be determined; absorber addition and withdrawal—the number of fixed localized absorbers is varied to give a method similar to the use of uniform air poisoning; pulsation—this technique is used to give subcritical measurements of rod worth; and rod run-in—the reactor is initially critical, and then the rods are run into the core, and then analysis of the flux response relates reactivity to rod movement. (auth)

17323 COMPARISON OF THEORETICAL AND EXPERIMENTAL CONTROL-ROD CALIBRATIONS IN THE LATINA REACTOR. G. Lesnoni and L. Sani (Ente Nazionale per l'Energia Elettrica, Rome). p.227-47 of STI/PUB/81.

Control-rod calibration for gas-cooled graphite-moderated reactors can be determined by the continuous balance technique. This method consists of compensating a flow variation in air pressure (a small leak from the vessel) by rod movement. Pressure coefficients are also measured for various control-rod configurations so that from the balancing air pressures at a number of positions calibration curves can be constructed. For the Latina reactor control-rod calibrations have been carried out at 20 and 180°C. As a guide to the measurements theoretical calibration curves and reactivities had previously been calculated. A comparison is made between the theoretical and experimental results to check the validity of the theoretical methods of calculation used in the design of gas-cooled graphite-moderated reactors. Also determined was the maximum number of rods which could be safely removed from the reactor for maintenance purposes during shutdown periods. (auth)

17324 PROBLEMS RELATED TO THE NUCLEAR AND MECHANICAL DESIGN OF THE PROGRAMMA REATTORE ORGANICO REACTOR CONTROL RODS. M. L. Brusa, L. Pierazzi, P. Fornaciari, and A. Gadola (Comitato Nazionale per l'Energia Nucleare, Rome). p.267-79 of STI/PUB/81.

The methods used for calculating the nuclear design of the control rods in the preliminary and operational phases of the PRO project are illustrated. Comparisons are made with experimental data and a summary is given of the programming studies carried out. Finally, consideration is given to certain problems connected with the mechanical design of the control rods. (auth)

17325 DESIGN, FABRICATION AND TESTING OF THE CONTROL RODS FOR THE EXPERIMENTAL GAS-COOLED REACTOR. J. W. Michel and C. A. Preskitt (Oak Ridge National Lab., Tenn.). p.409-40 of STI/PUB/81.

The criteria and methods used for the design of the control rods for the Experimental Gas Cooled Reactor are described. The final mechanical design was derived from extensive thermal and mechanical calculations and actual experience obtained by fabrication of a prototype rod. The nuclear design of the rod was based on detailed calculations, the accuracy of which was checked by comparison with a measurement of rod worth made with the Physical Constants Test Reactor. By means of a meticulous application of basic principles the calculation agreed with the measurement within the experimental uncertainty. The most important nuclear aspect of the design is the large amount of epithermal absorption, which approximately doubles the worth over that of a purely thermal absorber. The rod is of an articulated type and consists of hot-pressed B_4C-bushings clad in stainless steel. The unique design of the load-supporting members allows operation at cladding temperatures up to 1600°F. Comparisons are made with control-rod designs for other gas-cooled reactors, and justifications for the choice of design features and material selection are discussed. The fabrication procedures and the final test program for verification of the adequacy of the design are described. (auth)

17326 CONTROL OF REACTIVITY BY THE USE OF ABSORPTION ELEMENTS IN SOLUBLE FORM IN POWER-REACTOR MODERATORS. L. Dolle and G. Dirian (Centre d'Etudes Nucleaires, Saclay, France). p.703-32 of STI/PUB/81. (In French)

The advantages of a uniform distribution of the absorption element in the core of a power reactor are indicated, and possible uses of soluble compounds of nuclear poisons for reactivity compensation purposes are described. The various qualities required of an element which is to serve as a soluble poison in the moderator call for a detailed examination of its physical and chemical properties. In the end only a very limited choice is left between boric acid and sulfates of cadmium, lithium, and gadolinium. The evolution of the concentration of nuclear poisons in a reactor moderator is quantitatively studied in order to find out the relative effectiveness of consumption by neutron reaction and chemical purification. The power of the reactor will affect the choice of poisoning procedure. A comparison is made with poisoning by the xenon effect. The use of a purification circuit with ion-exchange resins to obtain a suitable anti-reactivity evolution program for the nuclear poison in solution in the heavy water in a power reactor is described. The effect of the nuclear poison in solution in the heavy water on the velocity of its radiolysis are examined. The economic aspects of reactivity control by homogeneous poisoning of the moderator are discussed. (auth)

17327 PROCEEDINGS [OF THE] ATOMIC INDUSTRIAL FORUM 1964 ANNUAL CONFERENCE, NOVEMBER 30–DECEMBER 3, SAN FRANCISCO, CALIFORNIA. VOLUME I. Robert N. Ubell, ed. (Atomic Industrial Forum, Inc., New York). Jan. 1965. 71p. (CONF-641112) $6.00

The development of nuclear power is discussed, with particular consideration of the program on water desalination. Nuclear power for military and space requirements is briefly considered. (D.C.W.)

17328 PRESSURE-TUBE DEVELOPMENT FOR CANADA'S POWER REACTORS. P. A. Ross-Ross and K. L. Smith (Atomic Energy of Canada Ltd., Chalk River, Ont.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-5, 12p. $1.00. (CONF-763-9)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The pressure-tube development program for power reactors in Canada is reviewed. The anisotropic strength properties of Zr-alloy, hot pressure tubes, and the thermal cycling stability of the internally insulated cold tubes is discussed. The determination of the anisotropic properties of the Zircaloy-2 pressure tubes has increased confidence in present reactor designs and has permitted a substantial increase in operating stress in experimental loop tubes. (P.C.H.)

17329 SITING AND SAFETY ANALYSIS OF SODIUM-GRAPHITE REACTORS. C. W. Griffin (Atomics International, Canoga Park, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-3, 8p, $1.00. (CONF-763-34)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The inherent safety features of the Sodium Graphite Reactor (SGR) concept were used for siting purposes and safety analyses; the safety features are discussed in detail. Typical reference accidents are analyzed and siting distances given. Analysis showed that an SGR up to 1000

Mw(e) could be safely constructed in the center of many industrial areas with confidence that the public would not be subjected to undue radiological hazards. (P.C.H.)

17330 NUCLEAR REACTOR HAVING CELLULAR CORE STRUCTURE. Howard E. Braun (to General Electric Co.). Canadian Patent 702,210. Jan. 19, 1965. Filed Dec. 2, 1961.

The core of a 350Mw dual-cycle power reactor was designed, which consists of an array of square flow passages containing slightly enriched unsegmented UO_2 fuel of 0.375 in. dia and light water as the moderator and coolant. Undesirable flux and power peaking is avoided. Control elements are arranged in the form of a cross in certain flow passages. (F.S.A.)

17331 NUCLEAR REACTOR SUPPLYING SUPERHEATED STEAM. André Huet. U. S. Patent 3,156,626. Nov. 10, 1964. Priority date Mar. 22, 1961, France.

A boiling liquid nuclear reactor is patented in which a plurality of fuel rods is disposed in circumferentially adjoining relationship to enclose between them a cylindrical space is a helical ramp along which the boiling liquid flows upward, and the steam is separated from the liquid by centifugal action. Inside the helical ramp at least one additional hollow fuel rod is so arranged that the separated steam can be guided over first the exterior and then the interior surface of the rod to superheat the steam. (A.G.W.)

Process Heat Reactors

Refer also to abstracts 17204 and 17327.

17332 (ORNL-3783) WATER DESALINATION INFORMATION MEETING, FEBRUARY 23-24, 1965. Abstracts of Papers. (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 35p. (CONF-650206). Dep.; $2.00(cy), 1(mn) CFSTI.

Abstracts are presented of 15 papers which were given on water research and nuclear desalination. Some of the topics treated include hyperfiltration, polarization, $CaSO_4$ solubility in solutions, Ti corrosion, fuel cycle costs, reactor types, evaporators, and plant optimization. (D.L.C.)

17333 (TID-21596) HIGH-TEMPERATURE ENERGY SYSTEMS. Quarterly Progress Report, August 1–October 31, 1964. (Bureau of Mines, Morgantown, W. Va. Morgantown Coal Research Center). 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The design and testing of a self-sustaining closed-cycle gas turbine operating on hydrodynamic gas-lubricated bearings are reported. The problems involved in continuously circulating suspensions in a closed loop, including erosion of equipment, are being studied. The feasibility of recycling suspensions through heat exchangers is being analyzed using aluminum and stainless steel particles suspended in nitrogen. A meter for measuring the flow of solids in gas-solid suspensions is described. A 250 psig simulated nuclear coal gasification system containing a fluidized-bed coal gasifier is described. Helium heated to 2200°F in the reactor supplies heat for the steam gasification of char-bituminous coal pretreated to destroy its caking properties. The testing of alloys for exchanger tubes in externally heated gasifiers is discussed. (N.W.R.)

17334 SEA-WATER CONVERSION USING A SMALL NUCLEAR HEAT SOURCE. T. R. Scanlan (American Machine and Foundry Co., Waterford, Conn.), A. G. Schoenbrunn, and W. Minners. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-8, 7p, $1.00. (CONF-763-38)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The investigation of a small nuclear heat source for use in operating a newly developed, multieffect, multistage (MEMS) flash-distillation plant is reported. The nuclear plant considered is of 21 megawatts thermal capacity. It is basically an upgraded research reactor using pressure-tube fuel elements containing UO_2 fuel. The new MEMS flash-distillation cycle operates at considerably higher efficiencies than present-day multistage flash-distillation plants. (auth)

Production Reactors

Refer also to abstract 15415.

17335 (HW-61794) NPR FREQUENCY RESPONSE ON AN ANALOG COMPUTER. G. R. Taylor (Hanford Atomic Products Operation, Richland, Wash.). Sept. 29, 1959. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The frequency response characteristics of NPR are studied using both open and closed reactivity loops, using an analog simulator. Sinusoidal variations in control rod positions and in inlet-water temperature are considered, at frequencies of 0.001 to 10 cps for both these parameters. (T.F.H.)

17336 (HW-83716) ANALYSIS OF PRIMARY LOOP EMERGENCY COOLING TEST DATA OBTAINED DURING START-UP TESTING OF N-REACTOR. H. G. Johnson (Hanford Atomic Products Operation, Richland, Wash.). Sept. 1, 1964. Contract AT(45-1)-1350. 111p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The transient data which were recorded on high speed oscillograph recorders during the cold and hot emergency cooling system tests run as a part of the startup testing of N-Reactor at zero power were analyzed. The data permit comparisons to be made between design values and actual experimental values, the most important of which are the dump line flow rates. The experimental dump rates were determined by a direct interpretation of dump tank liquid level-time data and by a heat balance around the dump tank using experimental temperature data. The experimental rates so determined bracket the calculated values used in studies previously made. The experimental rates arrived at by the heat balance method are believed to be the better of the two sets of experimental data, and these rates are found to be from 0 to 16 per cent below comparable calculated rates. Because justification does not exist for calculating and applying empirical correction factors to bring calculated values into line with experimental values on the basis of this one bit of test information wherein there is quite good agreement, it is recommended that calculated dump flow rates continue to be used in future studies without the application of empirical correction factors. Also, the agreement of the experimental and calculated flow rates tends to validate old studies wherein calculated dump line flows were used to establish total flow through the reactor and rates of primary loop depressurization for accidents requiring the use of the emergency cooling system. Previously calculated primary loop flow coastdown data are found to be in good agreement with experimental data taken during the hot emergency cooling test. The dump tank generally contained the quench water during the hot dump test. However, some water spilled over the overflow weir, and hence to the river, just after the V4 dump valves were opened. Extrapolation of the test data leads to the conclusion that tank quench water will surge over the tank's concrete walls as well as over the overflow weir just after the V4 valves are opened with a dump of the primary loop from full power operation. However, the existing tank will be satisfactory for containing the water after the initial surges. The cold and hot tests pointed out a serious problem on the response time of the emergency cooling system's low flow switches. New switches with small volumetric displacement were since substituted for the original switches to eliminate the problem. (auth)

17337 (HW-84281(p.6.11-13)) N-REACTOR PRESSURE TUBES. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation.

Test results indicated that a hoop stress of 25,000 psi has a definite effect on the orientation of hydride platelets in

Zircaloy-2 pressure tubing, an effect not noted at 10,000 psi. Two tests on irradiated Zircaloy-2 pressure tubing show an improvement of about 5% in creep resistance over similar material in the unirradiated state. One test on hydrided Zircaloy-2 pressure tubing indicates a slight decrease in creep resistance as compared with unhydrided material. (auth)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

Refer also to abstract 15825.

17338 (GEAP-3455) N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. FUEL ASSEMBLY TOP TIE PLATE LEAF SPRING TESTS. R. G. Cochran (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept. Jan. 10, 1961. Contract AT(04-3)-189. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The analysis of data and tests performed to ascertain the dimension to apply to the upper tie plate leaf springs of the N. S. Savannah Core II fuel assemblies designed by General Electric Company is reported. The as-built N. S. Savannah Core I fuel containers into which the Core II fuel assemblies will be placed, were not fabricated within drawing tolerance. It is, therefore, necessary to examine the as-built container dimensions and deflection characteristics in order to arrive at workable fuel assembly leaf spring dimensions. Test on the single cell container and leaf spring were conducted. On the basis of the analysis it is recommended that the tie plate leaf spring dimensions should be 8.789 and 8.814 inches for second and third pass fuel assemblies, respectively. (auth)

17339 (GEAP-3583) N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. FUEL ROD VIBRATION. Final Report. C. M. Shields (General Electric Co., San Jose, Calif.). Atomic Power Equipment Dept. Nov. 1, 1960. Contract AT(04-3)-189. 108p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Data obtained from flow tests in the General Electric facilities followed the general pattern given by published data. However, the General Electric measured deflection from vibration was approximately two and a half times the predicted value. This greater deflection was attributed to a more flexible type of construction used in the General Electric type fuel assembly. The reference equation had its constants revised to match the General Electric data. The deflection predicted by the revised equation is .009" at reactor operating conditions. (auth)

17340 (IDO-17038) RADIOLOGICAL ASPECTS OF SNAPTRAN 2/10A-3 DESTRUCTIVE TEST. O. L. Cordes, R. P. Bird, G. A. Dinneen, and J. R. Fielding (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan. 1965. Contract AT(11-1)-205. 77p. Dep.; $3.00(cy), 2(mn) CFSTI.

Information for the Aerospace Safety Program was acquired by subjecting a SNAP 2/10A reactor to a simulated water immersion accident which resulted in destructive disassembly of the reactor core. An extensive monitoring grid used to monitor the radiological effects of the destructive excursion and subsequent release of fission products is described. An analysis of the data is included which indicates that the direct radiation hazards were low and that the only fission products released to the environment were less than 4 percent of the noble fission gases. Halogens that escaped from the fuel were retained in the environmental water. (auth)

17341 (NAA-SR-10496) PROGRESS REPORT FOR SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) GENERAL SUPPORTING TECHNOLOGY, AUGUST–OCTOBER 1964. L. S. Mims and R. G. Courson (Atomics International, Canoga Park, Calif.). Jan. 30, 1965. Contract AT-11-1-GEN-8. 27p. Dep.; $2.00(cy), 1(mn) CFSTI.

Comparisons of ZrH_x spectral calculations with experimental data are given. Computer design studies of the neutron collimator for the STIR are discussed. Calculated and observed hydrogen leakage rates for pulse-heated ZrH_x rods are compared. The results of the MORL applications study are discussed. (auth)

17342 (NAA-SR-Memo-8339) SMALL SHAKER RESONANCE SEARCH METHOD. H. R. Kapp (Atomics International, Canoga Park, Calif.). Sept. 30, 1964. Contract AT-11-1-GEN-8. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A simplified method of resonance determination utilizes the phase relationship between the periodic force applied to a structure and the resulting acceleration of the vibrating structure at the driving point. A theoretical treatment of the reasoning on which the method is based is set forth in this report; instrumentation used to accomplish this method of resonance determination during the SNAP R/C 10 tests is presented. (auth)

17343 (NAA-SR-Memo-10293) SHORT CYLINDER ANALYSIS. C. C. Rampton (Atomics International, Canoga Park, Calif.). Aug. 18, 1964. Contract AT-11-1-GEN-8. 98p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

An analysis of short cylinders for any edge loadings is presented and tables are given to aid in the solutions. The complete solution of the problem is given. When the cylinder becomes long, part of the complete solution becomes very small and may be neglected. However, for short cylinders the complete solution must be used. An analysis procedure is given for using this paper and its tables to solve deflection, slope, moment, and shear at any point along the cylinder. (auth)

17344 (NAA-SR-Memo-10660) SNAPTRAN 10A/2–1 CRITICAL ASSEMBLY. R. P. Johnson (Atomics International, Canoga Park, Calif.). Nov. 1, 1964. Contract AT-11-1-GEN-8. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The SNAPTRAN 10A/2–1 reactor was brought to criticality and loaded to a full core configuration using: 37 uninstrumented fuel elements; and 8 instrumented and 29 uninstrumented fuel elements. Criticality was achieved with the 34th fuel element in the first case, and with 35 fuel elements in the second case. The critical loading was increased in the second case due to the addition of 18 in-core energy probes. The approaches made during each critical loading were performed in a conservative and safe manner. Extrapolations to criticality were made with the four control drums completely withdrawn, and with one, two, three, and four control drums inserted to the most reactive position. The in-core instrumentation was installed at different phases throughout the loading to the final full core configuration. In-core instruments include: flux chambers, strain gages, internal fuel element thermocouples and pressure indicators, external fuel element thermocouples, grid plate thermocouples, and energy probes. Of the 105 detectors permanently installed in the SNAPTRAN 10A/2–1 reactor, which will be used during the static and transient phases of the test program, only two failed upon installation. (auth)

17345 (NAA-SR-Memo-10667) SNAP 10A PbSnTe T/E PUMP S/N-038 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International, Canoga Park, Calif.). Nov. 4, 1964. Contract AT-11-1-GEN-8. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The SNAP 10A PbSnTe T/E Pump S/N-038 was Acceptance Tested. Data are submitted with a short summary of the results. The maximum output obtained during the orbital full-flow test was measured as 15.00 gpm of 1010°F NaK at a pressure of 1.060 psi. The maximum output obtained during the pre-reactor-startup test at a NaK temperature of 90°F was measured to be 0.29 gpm at a pressure of 0.00415 psi, with a startup current of 40 amperes d-c. (auth)

17346 (NASA-CR-59366) A COMPARATIVE MISSION ANALYSIS FOR SOLAR-HEATED HYDROGEN PROPULSION SYSTEM. VOLUME II. MISSION ANALYSIS. Final Report. (Aerojet-General Corp., Azusa, Calif.). Mar. 1964. Contract NAS-7-230. 123p. (N64-33917; L0774-01-9(Vol.II)). $4.00(CFSTI).

Energy requirements for space maneuvers, and a method of comparing various propulsion systems of interest, are presented. (auth)

17347 (NASA-TN-D-2712) ANALYSIS OF TURBOPUMP FEED SYSTEMS FOR HYDROGEN-NUCLEAR ROCKETS. Warren J. Whitney (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Mar. 1965. 19p. $1.00(CFSTI).

An analysis was made of turbopump feed systems for hydrogen-nuclear rockets. The study was concerned with investigating the feasibility of low temperature topping turbine systems, bleed rates for bleed turbine systems, and the possible advantage of a combination bleed and topping system. The range of chamber pressure investigated was from 300 to 1000 pounds per square inch absolute, and the range of system loss assumed was from 350 to 750 pounds per square inch. Conservative estimates of the pump and turbine component efficiencies were used, and conservative mechanical design limitations were observed. It is felt, therefore, that the results are commensurate with current mechanical design technology and component performance expectations. The results of the topping turbine driven feed systems showed that for turbine inlet temperatures of 1200°R or above the topping turbine pressure ratio would be small and would not represent a major consideration affecting the system feasibility. The feasibility of topping systems was shown to be critically dependent on turbine inlet temperature in the range 300 to 500°R. A low temperature or waste heat topping system having a turbine inlet temperature of 300°R was shown to be feasible at a 400 psia chamber pressure, marginal at 600 psia, and not feasible for chamber pressures above 600 psia. The bleed rates that were required for the range of operating conditions used herein varied from 0.037 to 0.101 for a single-shaft bleed turbine system and from 0.027 to 0.076 for a two-shaft bleed turbine system. The decrease in bleed rate cited is the reflection of improved turbine performance of the two-shaft bleed system, which effects a six-stage turbine within the mechanical limitation of three stages per unit. A combined bleed and topping system was examined for system conditions of 800-psia chamber pressure and 450-psi system loss. The example case, at which the topping turbine developed 0.75 of the total pump power, resulted in a bleed rate of 0.029. The corresponding bleed rates were 0.0725 for a single-shaft pure bleed system and 0.054 for a two-shaft bleed system. Thus, the combination bleed and topping system offers an advantage in bleed rate over a pure bleed system for assumed engine conditions for which a pure topping system would not function. (auth)

17348 (NP-14795) NUCLEAR ANALYSIS OF GASEOUS CORE REACTORS. T. F. Plunkett and R. J. Holl (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). May 23, 1963. 60p. (SM-44041)

A nuclear analysis was performed for gas core reactors suitable for space propulsion. Calculational methods were evaluated and multigroup diffusion theory was selected. A survey in spherical geometry evaluated reflector materials, nuclear fuels, reactor dimensions, and temperature effects. Two-dimensional results for a finite cylindrical reactor are included. The study showed that extremely high fuel loadings were required for a propulsion reactor. (auth)

17349 (ORNL-3726) IODINE VAPOR ADSORPTION STUDIES FOR THE NS "SAVANNAH" PROJECT. R. E. Adams and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

An experimental program was undertaken to determine the efficiencies of the iodine sorption systems installed aboard the NS Savannah. The function of these systems is to prevent escape of radioiodine from the reactor compartment in the event of a reactor accident. The results of this program are reported. Laboratory tests conducted under accident conditions on charcoal-adsorber units, reduced in scale but otherwise identical with those in the ship, showed their efficiency (for removal of iodine vapor from air-steam mixtures) to be 99.86 ± 0.07% at the 95% confidence level. Two methods were developed for in-place testing of adsorber systems, one using ^{131}I with radioassay and the other using ^{127}I with activation analysis. Both methods were applied on board the NS Savannah. Fifty-six shipboard in-place tests, conducted under various circumstances, demonstrated the system efficiency to be greater than 99.9% and showed that the adsorbers had been installed so that their full efficiency could be realized. Laboratory studies of iodine adsorption indicated that certain iodine compounds, which are more volatile than iodine and which can occur in very small amounts, are adsorbed by charcoal less efficiently than is elemental iodine, especially under moist room-temperature conditions. The probable presence of these compounds did not appear to limit seriously the efficiency of the systems in the large-scale tests under steam conditions. A method using Freon for testing adsorbers showed little promise for shipboard application because of interference by humidity at levels expected in the ship. An adsorber was developed for environmental iodine monitoring. It was concluded, based on results from both laboratory study and shipboard testing, that the adsorber system as installed on the ship could be expected to retain iodine with an efficiency of 99.86% in the event of an accident. (auth)

17350 (RTD-TDR-63-3002) RE-ENTRY AND DISPOSAL PHENOMENA FOR NUCLEAR AUXILIARY POWER SYSTEMS. THE SCALING OF PROCESSES OF SIGNIFICANCE IN THE RE-ENTRY OF NUCLEAR FUEL ELEMENTS. B. M. Leadon (General Dynamics/Astronautics, San Diego, Calif., Space Science Lab.). Nov. 1963. Contract AF29(601)-5893. 41p. (AE-63-0138; AD-425407). $4.60(CFSTI).

Model scaling laws are formulated for several physical phenomena associated with re-entry and dispersal of the debris from an orbiting nuclear reactor or power source. These phenomena include nonlifting and tumbling free fall, aerodynamic heating, thermal stress and transient temperature, gas desorption, and sorption expansion in homogeneous solids. Prototype scale trajectories are found to be possible using scale models in the case of spheres or tumbling rods. Aerodynamic heating in hypervelocity flight or ground test is shown, from semi-empirical equations, to be simulated under certain conditions. Transient heating, degassing and the resulting stressing of homogeneous solids are capable of only very limited simulation in model tests. Stressing due to outgassing is discussed. (auth)

17351 (RTD-TDR-63-3054) BURNUP ENHANCEMENT FOR RE-ENTERING NAP SYSTEMS. Ellis L. Foster, Jr. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1963. Contract AF29(601)-4939. 74p. (AD-423411). $8.10 (CFSTI).

The feasibility of enhancing the atmospheric burnup of a ZrH–uranium nuclear fuel upon reentry from orbit by addition of small amounts of alloying elements to the fuel was studied. Thirty-eight different modified fuel compositions were prepared and evaluated. The effects of various additives on fluidity, fabricability, ease of hydriding, hardness, and microstructure of the fuel alloy were determined. Thirty-two separate model fuel elements representing 25 most promising alloys based upon their apparent fluidity and ease of hydriding were exposed to simulated reentry conditions in the exhaust of an oxygen–hydrogen rocket motor. Samples were exposed for 2.5 to 8.0 seconds at a stagnation heat flux level of approximately 370 Btu/(sq ft)/(sec). Ablation was noted in all samples. Under the test conditions imposed, the products of ablation of the reference hydride fuel were definitely molten. A phenomenology of the ablation of the reference hydride fuel was described. (auth)

17352 (SC-RR-65-13) RE-ENTRY FLIGHT DEMONSTRATION NUMBER TWO. INTERIM FLIGHT-TEST REPORT. L. O. Cropp, W. H. Everhart, L. J. Keck, R. D.

Klett, M. M. Robertson, H. R. Spahr, I. B. White, and D. Parsons (Sandia Corp., Albuquerque, N. Mex.). Jan. 8, 1965. Contract AT(29-1)-789. 96p. Dep.; $3.00(cy), 3(mn) CFSTI.

A summary and brief evaluation of the RFD-2 flight-test data is presented. (auth)

17353 NUCLEAR ROCKETRY: THE PHOEBUS PROJECT. Roderick W. Spence. THE ORION PROJECT. Stanley Ulam. Nucl. News, 8: No. 1, 21-6(Jan. 1965).

The Phoebus program for developing a larger and more powerful rocket reactor, with high temperature resistance, long lifetime, and low weight, is reviewed. The relation with the Kiwi program, the use of clustered engines, comparison of nuclear and chemical rockets, results of project Rover testing and achievements to now, and projected tests on Phoebus reactors are discussed. The Orion project, to obtain still higher specific impulses with better ratios of payload to total vehicle weight, is considered. The operating principle, nuclear pulse propulsion using nuclear bomblets stored in the vehicle, is surveyed. The problem of construction and testing of such a vehicle without violating the Test Ban Treaty is mentioned. (M.J.T.)

17354 SPACE NUCLEAR POWER: SNAP-50/SPUR. William G. Osmun. Space/Aeron., 42: No. 7, 38-45(Dec. 1964).

The design and status of the SNAP-50/SPUR system is discussed, with consideration of design factors, materials selection, and testing. (D.C.W.)

17355 ENGINEERING ASPECTS OF A PROTOTYPE MARINE CONTROL STATION. R. Engevik (Institutt for Atomenergi, Kjeller, Norway). p.531-70 of STI/Pub/81.

A sound recommendation is sought for the choice of a control-element drive mechanism for a ship reactor. Among many alternatives, one has been brought through the stages of construction and laboratory tests. The principle of the control movement is a rack and pinion transmission through a conventional high-pressure shaft seal; hence a conventional dry motor and gear unit has been applied. The solution enables the use of positive rod indication. For "fast-in" or "scram" operation, a hydraulic cylinder energized from an air/water bottle has been developed. The hydraulic scram system has been optimized on low hydraulic losses. The use of internal ports and a direct mounted-on "multiport" scram valve has almost eliminated external tubes. This feature reduces hydraulic losses and makes the complete unit less sensitive to damage. Tests show that a hydraulically balanced side valve made of chromium steel parts, of different hardness, solenoid/spring forced, can be safely operated in water without the risk of galling. The choice of material is of great importance in the design of a mechanism for use in high-temperature water. The low-carbon chromium steels, properly heat-treated and machined to a smooth surface, appear to be satisfactory both from the corrosion and wear standpoints. Hardened chromium steel in connection with metal-impregnated graphite is a good bearing combination in water under moderate loads. Because the rack and pinion mechanism is space-consuming, reactors having close spacing of the control rods may preclude the use of this system. On the basis of the tests carried out in the laboratory, the system described has proved robust and reliable and meets the rather strict marine reactor requirements. Cost estimates have shown that such a drive mechanism can be produced at a reasonable price, an important point in the competition with conventional propulsion machinery. (auth)

Research and Test Reactors

Refer also to abstract 16014.

17356 (AEET/HP/TM-11) STUDY OF AIRBORNE RADIOACTIVITIES IN THE OPERATION OF A HIGH FLUX RESEARCH REACTOR (CIR). S. D. Soman and P. Abraham (Atomic Energy Establishment, Trombay (India)). 1964. 25p. Dep.(mn).

Studies were made on the radioactivity in the exhaust air from the 40 Mw Canada India Reactor. Gaseous and particulate activities were studied by decay and gamma ray spectrum measurements. The gaseous activity is due to (a) induced activities like ^{41}Ar and $^{14}CO_2$ and (b) gaseous fission products. The rate of release of argon-41 from the stack was measured to be about 640 curies per day at 40 Mw. The rate of production of argon-41 in all the air spaces in the reactor structure is estimated to be 950 curies per day. This discrepancy can be explained to be due to static air in the fuel rod annulii, which does not contribute much to the release. The different methods adopted for the estimation of argon-41 are outlined. Radiocarbon produced by different reactions of neutrons with the constituents of air has been theoretically estimated to be 7.24 curies per year. A relation is obtained which can be used to estimate the amount of carbon-14 produced in the coolant air of any air-cooled reactor, if one measures the amount of argon-41 produced. A simple form of electrostatic precipitator was used to collect daughter products of gaseous fission products. The particulate daughters of gaseous fission products, e.g., ^{89}Rb, ^{89}Rb, ^{91}Sr, ^{91}Rb, ^{138}Cs, ^{139}Ba, and ^{140}Ba, were identified. The beta decay of particulate activity collected on filter paper air samples from the exhaust system shows the presence of sodium-24 and some fission product activities. The peaks in the gamma ray spectrum of the samples correspond to the gamma energies of sodium-24 and the prominent fission products. The presence of sodium-24 was confirmed by chemical analysis. These measurements have shown that the rates of release of ^{90}Sr and ^{131}I from the CIR stack are 22×10^{-2} and 200 μC respectively, per day at 40 Mw. Sodium-24 is formed by the activation of aluminium and escapes into the exhaust stream by recoil, whereas the fission products are presumed to be formed by the fission of the uranium present as an impurity in the aluminium used for the fabrication of components in the reactor structure. (auth)

17357 (ANL-6778) STRUCTURAL ANALYSIS OF FARET CORE SUPPORTS UNDER MECHANICAL AND THERMAL LOADINGS. M. M. Chen (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 32p. Dep.; $2.00(cy), 1(mn) CFSTI.

A structural analysis was made of the core support grid of the Fast Reactor Test Facility (FARET). This structure consists of three circular plates which form high- and low-pressure plenums for achieving a coolant flow distribution. These plates are perforated for insertion of the fuel rods. The weight of the fuel assemblies and the coolant pressures in the plenums constitute the principal mechanical loading of the core support grid. In addition, thermal loadings arise because of the temperature distributions in the grid. A general solution was developed for the stress analysis of a core support plate which is subjected to these mechanical and thermal loadings for any rotationally restrained edge conditions. The resulting deflections and stresses were computed for various loading conditions by use of the IBM-704 computer. For the thermal analysis, a rotationally symmetric temperature distribution was assumed, varying linearly through the thickness of the plate. The analysis was based on classical small-deflection theory and the concept of the "equivalent solid plate" of O'Donnell and Langer. The solution was applied to a model which simulates the FARET core support subjected to a combined mechanical and thermal loading. (auth)

17358 (ANL-6915) FLUX TRAP EXPERIMENTS IN D_2O-MODERATED THORIA–URANIA CORES. K. E. Plumlee (Argonne National Lab., Ill.). Oct. 1964. Contract W-31-109-eng-38. 33p. Dep.; $2.00(cy), 1(mn) CFSTI.

Experiments are reported involving 25 D_2O and three small H_2O internal thermal columns (ITC), or flux traps, inside annular thoria–urania cores. The moderator and the radial reflector were D_2O. Several different fuel densities were used. ITC's were as large as 104 × 104 cm.

Radial activation plots indicated central peaks up to ten times the fuel zone average at the midplane, and five times the fuel zone maximum. Available fuel and facilities were used to obtain data for evaluation of computational methods, which were reported separately. The limited selection of fuel prevented optimization of experimental cores. (auth)

17359 (ANL-6965(p.84-90)) ADVANCED SYSTEMS RESEARCH AND DEVELOPMENT. (Argonne National Lab., Ill.).

Research and development devoted to core physics, critical experiments, and heat transfer in the Argonne Advanced Research Reactor are reported. Work on magnetohydrodynamic cells and regenerative EMF cells is also reported. (J.R.D.)

17360 (GNE/Phys/64-3) THE DESIGN OF A CRYOSTAT FOR THE AIR FORCE NUCLEAR ENGINEERING TEST FACILITY (thesis). Ernie Braunschweig (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Aug. 1964. 158p. (AD-603609). $5.00 (CFSTI).

A liquid helium cryostat for nuclear irradiation experiments to be performed at the Air Force Nuclear Engineering Test Facility was designed for use in the reactor beam tubes. Liquid helium consumption due to thermal heat transfer is reduced to 0.13 liter/hr by gas cooled shields around the sample chamber and in the transfer line. The low consumption rate will allow operation using liquid helium from a storage dewar. Gamma radiation is the largest heat source in the cryostat and must be reduced with a gamma shield. Fast neutron heating of the helium coolant is significant and may limit the fast neutron flux to which the cryostat can be exposed to less than 10^{12} n/cm^2-sec. Operating the cryostat with liquid helium in the reactor does not endanger reactor control or structure. The cryostat can be operated with a wide range of coolants and can be readily modified for any sample chamber smaller than a cylinder 4 inches in diameter and 8 inches long. (auth)

17361 (HW-84281(p.6.1-10)) PRTR PRESSURE TUBES. (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation.

Pressure tube inspections disclosed no fretting or mechanical damage of any significance. Gas gap measurements on Channel 1748 were out of standard and corrected by tube replacement. Burst test examination of PRTR Zircaloy-2 Tube 6079 showed that the tube had high burst test hoop strength and had capacity for hoop plastic deformation. Metallographic and eddy current test probe examination of a flaw in PRTR Zircaloy-2 Tube 5526, showed that the flaw's size was $1\frac{1}{2}$ in. long by $\frac{1}{16}$ in. wide by $\frac{1}{64}$ in. deep. Crack propagation experiments performed at room temperature with irradiated and unirradiated annealed specimens from PRTR Zircaloy-2 pressure tubes indicate that fast neutron exposure had no effect upon the crack propagation characteristics. The influence of the total PRTR environment upon the strength and ductility of PRTR Zircaloy-2 pressure tubes has been found to increase the burst test hoop elongation. This effect was found to have a much greater influence upon annealed material than upon material which has been cold worked. In addition, the effect of test temperature was determined and shows that the annealed material is influenced more by elevated temperature tests than by room temperature tests and that the cold worked material is influenced more by the room temperature tests. The irradiated tube testing facility has been in continuous operation during this quarter. Five PRTR burst tests, three PRTR stress rupture and four KER stress rupture tests were completed or are currently undergoing testing. (auth)

17362 (LA-3116) STATUS REPORT ON THE OMEGA WEST REACTOR. Robert Kandarian and Herbert T. Williams (Los Alamos Scientific Lab., Univ. of California, N. Mex.). June 1964. Contract W-7405-eng-36. 70p. Dep.; $3.00(cy), 2(mn) CFSTI.

The Omega West Reactor (OWR) is a thermal, heterogeneous, tank-type research reactor operated by the Los Alamos Scientific Laboratory. The reactor is light-water moderated and cooled, and utilizes aluminum-clad fuel elements of the Materials Testing Reactor (MTR) type. At the normal operating power of 5 Mw thermal, the reactor provides neutron fluxes up to 6×10^{13} n/cm^2-sec in the accessible experimental facilities. These facilities include 7 horizontal beam ports, a thermal column with 20 access ports of various sizes, 3 rabbit tubes, 2 air-filled vertical ports, and 4 in-core irradiation positions. Although the reactor was designed primarily as a research machine, it also serves as a test facility. A description is given of the reactor, its auxiliary systems, and its mode of operation as of February 1964. The extent of the radiation hazards to the public that might result from a nuclear excursion in the reactor is examined. (auth)

17363 (PAN-553/IX-A) DETERMINATION OF THE MATERIAL BUCKLING IN THE HELENA SUBCRITICAL ASSEMBLY BY TWO PARALLEL PLANES' METHOD. A. Mikulski (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Aug. 1964. 13p. Dep.

A description is given of the method used for the determination of the material buckling in the subcritical assembly. It is based upon investigation of the distribution of the thermal neutron flux over two parallel planes. This method is simple and eliminates the application of higher harmonics corrections. (auth)

17364 (PAN-563/IX-A) MACROSCOPIC NEUTRON DISTRIBUTIONS IN THE TWELVE-ELEMENT CORE OF ZERO POWER REACTOR ANNA. L. Adamski, E. T. Jozefowicz, K. Jozefowicz, and A. Szechter (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 26p. Dep.

The results of measurements of macroscopic distributions of neutron density, cadmium ratio, and spectral index in the twelve-element core of ANNA reactor are presented. The results include vertical distributions in water and graphite channels, distributions along the two main horizontal axes, and in the horizontal plane of symmetry. (auth)

17365 (PAN-581/XIV) REZUL'TATY IZMERENII I OBOZNACHENII PARAMETROV VODY PERVICHNOGO KONTURA REAKTORA EVA 3A 1962–1964r. (The Results of Measurements and Determinations of Typical Reactor Water Parameters in Swierk From 1962 to 1964). Z. Begushevski and T. Zelinska (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 5p.

At the date of the report (Aug. 1962) the exchange capacity of the 2 year old cation exchange materials was 0.43 mg equiv/ml or 65% of the exchange capacity of fresh materials. Corresponding data for anion exchange materials were 0.22 mg equiv/ml and 50%. The difference between cation and anion exchange materials was caused by adsorption of CO_2 from the deaerator. Following the filter replacement, a considerable water purification was observed in the first circuit. The electric conductivity fell down at an average of about 10%, the pH increased from 5.8 to 6.1, the dry precipitate reduced from 4 to 1 mg/l, and the content of chloride was reduced from 0.055 to 0.025 mg/l. The analysis of the reactor first circuit water indicated the predominate content of ^{54}Mw, ^{60}Co, ^{59}Fe, ^{124}Sb, and ^{24}Na. (R.V.J.)

17366 (SGAE-CH-10/1964) BESTRAHLUNGSMOGLICHKEITEN UND HERSTELLUNG VON RADIONUKLIDEN IM REAKTORZENTRUM SEIBERSDORF. (Irradiation Possibilities and Preparation of Radionuclides in the Seibersdorf Reactor Center). A. Burtscher and H. Sorantin (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria)). 1964. 43p. Dep.(mn).

The ASTRA reactor and its irradiation installation were briefly described. The nuclear reactions that can be used for radioisotope production were discussed. The production of radioisotopes, radioactive sources and standards, and labelled compounds at Seibersdorf is summarized. The packing and shipping procedures are outlined. (J.S.R.)

17367 (CEA-tr-X-552) EXPÉRIENCE EXPONENTIELLE DE LA COUCHE FERTILE D'UN REACTEUR A NEUTRONS RAPIDES. (Exponential Experiment in the Fertile Zone of a Fast Neutron Reactor). M. Nozawa, Y. Tomioka, T. Iijima, T. Nakamura, N. Hirakawa, and H. Gotoh (Japan Atomic Energy Research Inst., Tokyo). Translated into French from report JAERI-1087. [195?]. 130p. Dep.(mn); $10.10(fs), $4.10(mf) JCL.

As a preliminary study of a breeder reactor with fast neutrons, the behavior of neutrons in a layer containing natural uranium in the form of rods with hexagonal base was investigated. The system is constructed of 2.1 tons of natural uranium, stainless steel, aluminum, and cavities. The neutron source is a converter that transforms the neutrons leaving the thermal neutron column of the JRR-1 into fast neutrons. The energy spectrum of the neutrons, the flux distribution, and the fission ratio were measured at each point of the system by the nuclear emulsion method, the activation method, and the method using a fission chamber. The details of these various methods and the results obtained are reported. A safety analysis made before the initiation of the experiment is described. (tr-auth)

17368 RADIOLOGICAL PROTECTION FOR SUBCRITICAL THERMAL ASSEMBLIES. J. Rembser (Arbeits- und Sozialministerium des Landes Nordrhein-Westfalen, Dusseldorf, Ger.). Atomkernenergie, 9: 437-49(Nov.-Dec. 1964). (In German)

Important aspects of radiological protection for subcritical thermal assemblies are discussed. The handling of irradiated and nonirradiated fuel elements and the use of neutron sources are discussed. Shielding of subcritical assemblies in order to give estimates for the different dose rate contributions outside the assembly is considered. The radioactivity of fission nuclides which are formed during the short irradiation times of subcritical assemblies is discussed. Criticality problems are not considered. (auth)

17369 THE DETERMINATION OF THE TRANSFER FUNCTION OF THE REACTOR FR 2 BY OSCILLATION MEASUREMENT AND BY MEASUREMENT OF THE FUNCTION OF TRANSITION. H. W. Glauner (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 11: 21-6(Jan. 1965). (In German)

The transfer function of the reactor FR2 was determined at full power (12 Mw). The internal feedback by uranium and moderator temperature effects are demonstrated. For comparison the measured function was followed by an analytical determination using a simplified heat transfer circuit. Finally the transfer function was analyzed from the measured neutron flux after a step in reactivity. (auth)

17370 THE REACTOR CABRI. Jean Ailloud and Jean-Paul Millot. Energie Nucl., 6: 403-8(Nov. 1964). (In French)

The swimming-pool reactor Cabri at the Cadarache Nuclear Research Center achieved criticality on Dec. 21, 1963, and has been subjected to power excursion tests since last April. The reactor is to be used to study the effects of transient behavior in light-water-moderated reactors. The reactor and its auxiliary equipment are described, with emphasis on certain parts of the installation. (D.C.W.)

17371 CHARACTERISTICS OF THE URANIUM CONVERTER. FAPIG (Tokyo), No. 29, 283-9(Dec. 1963). (In Japanese)

In order to find the nuclear characteristics of the uranium converter installed in the Triga reactor of St. Paul's University, radiation detectors for measurements in water were designed and constructed, and the intensities, distributions, and attenuations in water of γ rays, thermal neutrons, and fast neutrons were measured near the surface of the uranium converter. The detectors used were γ-ray dosimeters in a lucite case (water-tight) for measuring γ rays, gold-foil or BF_3 microcounters in a lucite case for thermal neutrons, long counters using a BF_3 microcounter as the detector for fast neutrons, and threshold detectors covered with Cd for determining fast neutron spectra. It was found that γ rays and fast neutrons having an effective radius of 40 cm were emitted as the result of fission in the uranium converter and that high-energy background radiations existed at the same time. These background radiations included γ rays and thermal and fast neutrons, which leaked out of the reactor core through the thermalizing column. For the purpose of shielding experiments, it is necessary to measure the shielding effect on particular energy spectra of γ rays and fast neutrons and to remove the leaking thermal neutrons by using a cadmium plate. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17372 OUTLINE OF THE JRR-4, A SWIMMING POOL, RESEARCH REACTOR. Atushi Komeno and Toru Hasegawa (Hitachi Ltd., Tokyo). Hitachi Hyoron, 45: 1777-83(Nov. 1963). (In Japanese)

The JRR-4, a swimming-pool type thermal reactor, using enriched uranium, light-water moderated and cooled, is described. The reactor is being constructed by Hitachi, Ltd. at the Japan Atomic Energy Research Institute and will be completed about the end of 1964. The core of the reactor measures 405 × 336 × 600 mm and consists of 20 units of uranium fuel (each unit being composed of 15 fuel plates) and 7 control units. The fuel plates are 90% enriched U-Al alloy, totaling 3.3 kg of ^{235}U. Twenty-one graphite reflectors are used. The 7 control units mentioned include 4 coarse control plates, 1 fine control plate, and 2 scram plates, all of boron steel. The rated power output is 1000 kw(t) (the maximum 3000 kw) and the thermal neutron flux 10^{13}. The reactor will mainly be used for shielding experiments for a nuclear-powered ship. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

17373 AUTOMATIC START-UP OF A RESEARCH REACTOR. II. DESIGN OF A LOGARITHMIC COUNTING-RATE AND PERIOD METER, AND AUTOMATIC START-UP EXPERIMENTS. Takeo Fujisawa, Koichi Watanabe, and Kenji Sumita (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 350-61(Dec. (1964).

As a step toward putting into practice full range automatic start-up of a research reactor, the design problem of a logarithmic counting-rate and period meter (LCRPM) used for period control in the counter range is described. The design basis is to find the optimum point of compromise between requirements such as smaller period signal fluctuations and faster response of the LCRPM, under the condition that the pulse sequence coming from a fission counter is Poisson-distributed. The LCRPM thus optimized was then applied to automatic start-up experiments with JRR-1, ranging in power level from 3mw (or 20 cps) up to about 2 kw. The experiments demonstrated the applicability of the design method and the feasibility of full range automatic start-up. (auth)

17374 NON-INSTRUMENTED IRRADIATION FACILITIES AT THE GEESTHACHT REACTOR STATION. M. Kolb (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Ger.). Kerntechnik, 6: 508-12(Nov. 1964). (In German)

A survey is made of the different facilities used at the Geesthacht Reactor Station for the irradiation of samples which do not require continuous control of the condition of the sample. The experiences concerning these non-instrumented irradiation facilities are discussed with special regard to the sample transfer processes. (auth)

17375 FUSED $Li_2^6CO_3$ FOR ABSORBING SLOW NEUTRONS IN COLLIMATING SYSTEMS. B. M. Rustad, C. J. Christensen, and B. Skytte Jensen (Danish Atomic Energy Commission, Risø, Denmark). Nucl. Instr. Methods, 33: 155-6(Mar. 1, 1965).

Neutron collimating apertures fashioned from fused lithium carbonate, highly enriched in ^6Li, used in a high intensity thermal neutron beam facility at the Danish DR3 reactor are discussed. The properties of lithium carbonate are outlined. (C.E.S.)

17376 BEAM-PORT PERTURBATIONS IN WATER AND GRAPHITE. Sanford C. Cohen and John S. King (Univ.

of Michigan, Ann Arbor). Nucl. Sci. Eng., 21: 509-14(Apr. 1965).

The influence of the port void on the thermal-neutron scalar flux at the source plane and on the current at the exit plane of a beam port is examined experimentally and analytically. Activation experiments on 1.5-, 3-, and 5-in diameter ports inserted into the water and graphite reflectors of a swimming-pool reactor are compared with an elementary P_1 analysis. The exit current is found to be well predicted by the theory, which depends only upon a knowledge of the scalar flux distribution when the beam port is absent. (auth)

17377 NONDESTRUCTIVE STUDIES ON THE URANIUM DISTRIBUTION OF PRR-I FUEL PLATES. Jose O. Juliano and Pericles T. Meneses (Phillippine Atomic Research Center, Diliman, Quezon City). Philippine J. Sci., 93: 189-96(June 1964).

Direct gamma counting and autoradiography were used to study the uranium distribution in PRR-I fuel plates. The ^{235}U distribution was found to be homogeneous. The maximum standard deviation was 2.5%, and the average standard deviation was 1.6%. (M.C.G.)

17378 NONDESTRUCTIVE STUDIES ON THE STRUCTURE OF PRR-I FUEL PLATES. Jose O. Juliano and Pericles T. Meneses (Philippine Atomic Research Center, Diliman, Quezon City). Philippine J. Sci., 93: 199-205 (June 1964).

The thickness of aluminum cladding on PRR-I fuel plates, the thickness of the central Al–U alloy portion, and the percentage composition of the Al–U alloy were determined by nondestructive methods. Results are presented in tables and graphs. (M.C.G.)

17379 DIRECTORY OF NUCLEAR REACTORS. VOL. V. RESEARCH, TEST AND EXPERIMENTAL REACTORS. SUPPLEMENT TO VOLS II AND III). Vienna, International Atomic Energy Agency, 1964. 338p.

Data are given on pool- and tank-type light-water moderated, argonaut-type, solid homogeneous, heavywater moderated, graphite moderated, and fast research reactors. For each reactor, a presentation is made of: reactor physics data, core and fuel element details; diagrams of fuel element and reactor sections; information on core heat transfer, control, reactor vessel and overall dimensions, reflector and shielding, containment and cost estimate; research and experimental facilities; and diagrams and data on fluid flow. (M.J.T.)

17380 CONTROL-ROD WEIGHT AND THE IMPORTANCE COEFFICIENT OF DELAYED NEUTRONS IN THE VVR-M REACTOR. Yu. V. Petrov and T. I. Sumbaeva (Ioffe Inst. of Physics and Tech., Leningrad). p.73-8 of STI/PUB/81. (In Russian)

For active zones of small dimensions the effective contribution of delayed neutron to the chain reaction is considerably increased, because fewer escape as compared with prompt neutrons. For this reason, in the determination of control-rod worth from the reactor period it is necessary to know the importance coefficient for delayed neutrons. It can be shown by calculation that for the VVR-M reactor the effective fraction of delayed neutrons is $25 \pm 3\%$ greater than the normal fraction. The experimental control-rod worth obtained in the study of this effect agrees with the calculated value within the limits of experimental error. (auth)

17381 CALCULATIONS AND EXPERIMENTS OF THE POISON SHEET REACTIVITY IN THE HITACHI TRAINING REACTOR. S. Nakamura and H. Mitsui (Hitachi Ltd., Japan). p.79-106 of STI/PUB/81.

A method for calculating the control-rod reactivity is derived within the framework of the variational theory, which can be used for an arbitrary shaped reactor with infinite height. The reactivity of the poison sheets was measured in HTR in order to check the variational method and the conventional method. The variational method, the conventional method, and the experiment agreed. (auth)

17382 A DETERMINATION OF THE LIFETIME OF A SET OF PLUTO COARSE-CONTROL ARMS. P. M. Garvey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.249-65 of STI/PUB/81.

The Materials Testing Reactor PLUTO is controlled by seven coarse-control arms. These arms move as signal arms through the reactor core and are fabricated from cadmium sheet clad in stainless steel, the stainless steel being in direct contact with the D_2O moderator. In a consideration of the safe operation of PLUTO, it is important that the lifetime of these arms, with regard to the burnup of the cadmium, be accurately known. For an estimate of their lifetime each arm of the set was removed from the reactor after a known irradiation period, and the cadmium was analyzed for determination of the ^{113}Cd burnup. In the analysis the cross section of solutions of cadmium samples, which had been punched from each arm, was compared with a solution of natural cadmium, the cross sections being measured in the reactor GLEEP. The burnup distribution over each of the cadmium arms is presented and discussed with regard to an estimation of the lifetime of each coarse-control arm in the reactor. Also presented is the thermal-flux distribution over the surface of two of the coarse-control arms, as measured in DAPHNE, the zero-power mock-up of PLUTO. (auth)

17383 FABRICATION BY CO-EXTRUSION OF CONTROL RODS FOR THE BR-2 REACTOR. H. Massaux (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). p.365-79 of STI/PUB/81. (In French)

The control rods of the Belgian reactor BR-2 are cadmium tubes, clad inside and outside with aluminum. These tubes have been experimentally fabricated by co-extrusion. It has been found possible, in a single operation, to obtain the finished aluminum element with a slightly alloyed cadmium center; the thickness varies by a maximum of 8%, and the end irregularities are very short. This method also gives a very close contact between the center and the cladding, and provides an extremely rigid tube. (auth)

17384 CONTROL RODS IN HIGH-FLUX SWIMMING-POOL REACTORS. PART I. P. Ageron, P. Blum, G. Denielou, P. Denis, and C. Meunier (Centre d'Etudes Nucleaires, Grenoble, France). p.487-507 of STI/PUB/81. (In French)

Control-rod problems in open swimming-pool high-flux and high-specific-power research reactors are examined in the light of the calibrations and experiments made during the construction of the Siloe reactor. Control-rod operating experience for this reactor at 13 Mw is also described. The following are considered in turn: reactivity balances and reactivity values for the different types of rod tested (cadmium, B_4C, rare-earth, and combinations of these different elements); flux peaks set up in the core by the presence of the control rods, their incidence on the specific power, the fast fluxes that can be obtained, and means of increasing them; the technological problems involved in constructing the rods; and in-pile cooling, vibration, deformation, and scram-time problems. Studies on control rods in open swimming-pool reactors operating in the 10 to 30 Mw range are briefly summarized. (auth)

17385 OPERATIONAL EXPERIENCE WITH THE CONTROL RODS OF THE HIGH FLUX REACTOR AT PETTEN. A. Tiktak (Reactor Centrum Nederland, Petten, Netherlands). p.509-27 of STI/PUB/81.

After a description of the control-rod mechanism of the High Flux Reactor at Petten, special attention is given to the various materials of the components. During a two-year operational period a number of troubles, such as spurious rod drops, position indication of the control rod, rod drop failures, and seizing of the rollers of the control-rod guides in the core, have been experienced. The improvements and tests to overcome these troubles are described. Data concerning normal operation of the rods are given. Finally, the control-rod calibration method and the disagreement with the behavior during 20-Mw operation are discussed. (auth)

17386 THE OPERATION EXPERIENCE AND THE UTILIZATION OF THE TRIGA REACTOR OF THE INSTITUTO DE PESQUISAS RADIOATIVAS. J. I. Vargas, M. Campos, and O. C. Ferreira (Universidade de Minas Gerais, Brazil). 20p. (IPR-44; CONF-631104-1)

From Meeting on the Utilization of Research Reactors, São Paulo, Brazil.

The operation and uses of the reactor over a two-year period are reviewed, including operation costs, personnel organization, determination of reactor parameters, training of nuclear engineers, isotope production, and research, particularly in radiochemistry and solid state physics. (D.C.W.)

17387 NUCLEAR REACTOR SYSTEM. Charles E. Clifford and Harold Robert Zeitlin (to General Dynamics Corp.). U. S. Patent 3,156,624. Nov. 10, 1964. Filed Jan. 30, 1961.

The nuclear reactor system patented provides for the irradiation of relatively large objects in two spaced-apart positions by movement of the reactor core. The reactor core is supported in a tank filled with a suitable liquid. The tank is generally elliptical in shape, and semi-cylindrical projections on opposite sides of the tank define recesses for receiving the core. A carriage is provided for moving the core between the recesses. Adjacent to each recess is an irradiation room whose shielding is so arranged that one room is used to irradiate objects with fast or core neutrons and the other is used to irradiate objects with slow or moderated neutrons. In order to permit safe access to one of the exposure rooms while the other is being irradiated, a movable radiation shield or gate is provided in the tank between the two irradiation facilities. Specimens lowered into the tank may also be irradiated. (A.G.W.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstract 15784.

17388 (HW-84467) RESEARCH AND DEVELOPMENT ACTIVITIES. FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, July–September 1964. A. M. Platt, ed. (General Electric Co., Richland Wash.). Hanford Atomic Products Operation. Oct. 1964. Contract AT(45-1)-1350. 39p. Dep.; $2.00(cy), 1(mn) CFSTI.

Two runs with full-level radioactive feed were completed in the cooperative BNL-HL Hot Cell Glass Experiment. Both runs were operationally successful and radiologically uneventful. An excellent glass was obtained from the second run. In associated studies on glass formations it was found that the solubility of glass was markedly affected by the thermal history of a sample. Various waste-additive compositions were evaluated as to suitability for use in waste fixation processes involving spray calciners coupled to continuous melters. The systems Purex waste calcine—B_2O_3–CaO and Purex waste—SiO_2Na_2O were studied. Glasses were obtained with both systems; those for the latter system all had fusion temperatures above 900°C. Viscosity, density, and nitrate concentration in the bottoms of a phosphate glass process evaporator operating at a steady state were determined. All three dependent variables were measured as a function of bottoms temperature and phosphate-to-metal ion equivalent ratio. Studies were initiated with a new 14-in.-dia spray calciner in which both calciner-melter coupled and uncoupled studies were conducted with emphasis on Purex type wastes. Since the glass or melt fluxing agents may be readily incorporated into spray calciner liquid feed or added to the continuous melter as a separate dry chemical, a separate direct feed to the melter was scouted. Results of studies indicate that either method is feasible. Steam stripping of Purex tank farm condensate, following hypochlorite treatment to reduce bacterial activity, produced a relatively clear feed which appears to be satisfactory for thin precoat ion exchange bed treatment. Electrodeionization of alkaline Purex condensate with a resin packed unit removed greater than 95% of the $^{103-106}Ru$ and ^{137}Cs activity present out to 5000 column volumes throughput. Results of laboratory studies indicate that Cs recovered by ion exchange with zeolites from Purex alkaline supernatant waste, can be readily purified by alum crystallization for use in the Hanford Isotopes Plant. The amount and composition of insoluble material formed by evaporation of ammonium carbonate eluate solutions from zeolite ion exchange beds was investigated. Self-diffusion coefficients for Na, Sr, and Cs were determined in the natural zeolites erionite, phillipsite, and clinoptilolite, and the synthetic zeolites Linde 13X and 4A. (auth)

17389 PROBLEMS OF RADIOACTIVE WASTES BEING SOLVED IN THE INSTITUTE OF NUCLEAR RESEARCH OF THE CZECHOSLOVAK ACADEMY OF SCIENCES. Lubomir Berak, Zdenek Dlouhy, Frantisek Kepak, Jiri Napravnik, Jarmila Ralkova, Jaroslav Saidl, Ludmila Schejbalova, Vladimir Vesely, and Josef Zaruba (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 9-11(Jan. 1965). (In Czech)

Investigations of radioactive waste disposal are reviewed. Some methods developed and proved are briefly described. Several of them became a basis for pilot plant and full operation equipment design and construction. (auth)

GENERAL AND MISCELLANEOUS

17390 (AERE-R-4792) BIBLIOGRAPHY OF UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON NEPTUNIUM, 1957–1964. R. W. Clarke, comp. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1964. 57p. Dep.; $1.60(BIS), 8s.(HMSO).

A total of 298 references is presented on the chemistry, physics, metallurgy, and nuclear properties of neptunium. The references cover the period late 1957 to autumn 1964, and a subject index is included. (D.L.C.)

17391 (BDX-613-39) MODERN GAGE CONTROL. Leo Tschechtelin (Bendix Corp., Kansas City, Mo.). [nd]. Contract [AT(29-1)-613]. 40p. (CONF-630404-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 3rd Annual Quality Control Conference, Toledo.

The following aspects of gage control are discussed: gage availability, economics, scheduling, type, dimensional accuracy, and surveillance using electronic data processing methods. (D.L.C.)

17392 (BDX-613-43) A STANDARDS AND CALIBRATION PROGRAM IN A LARGE DEFENSE PLANT. J. F. Hadley (Bendix Corp., Kansas City, Mo.). Nov. 1963. Contract [AT(29-1)-613]. 12p. (CONF-631108-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IEEE Symposium on Measurements and Instrumentation, Kansas City, Mo.

A description is given of Bendix's standards and calibration system and its relationship to the AEC Standards and Calibration system and to the National Bureau of Standards. The primary standards laboratory maintains reference standards for all electrical, environmental, and dimensional measurements in the plant. Five departments are provided for periodic calibration of all measuring instruments. Evaluation of the calibrations and vendor calibration are discussed. (D.L.C.)

17393 (BDX-613-56) NEW POTENTIAL IN RIGID POTTING COMPOUND. R. L. Sadler and E. F. Jacobs (Bendix Corp., Kansas City, Mo.). [1961]. Contract [AT-(29-1)-613]. 16p. (CONF-640505-1). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From Society of Plastics Engineers, Milwaukee.

Three rigid epoxy potting compounds are described which were used for potting large structural-type electrical packages. The requirements for such use are discussed, and the advantages of fillers are outlined. Manufacture and production difficulties are discussed, and the properties of the formulations are listed. (D.L.C.)

17394 (BNL-841) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, SEPTEMBER 1–DECEMBER 31, 1963. Jean H. Reynolds, ed. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 115p. Dep.; $4.00(cy), 2(mn) CFSTI.

Separate abstracts were prepared for the six sections on reactor physics, chemistry and chemical engineering, radiation, hot laboratories, metallurgy, and engineering. (N.W.R.)

For abstracts of individual sections see: 15331, 15332, 15565, 15991, 17179, and 17180.

17395 (BNL-7860) ENDOGENOUS CIRCADIAN RHYTHMS AND THE RESPONSE OF LEMNA PERPUSILLA TO SKELETON PHOTOPERIODS. William S. Hillman (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT 30-2-GEN-16. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effects of various photoperiodic schedules on the flowering of Lemna perpusilla were studied in plants grown on media containing sucrose, so that photosynthesis was not required for growth. Results indicate the presence of an endogenous circadian rhythm that persists for at least 48 hrs in total darkness. It was concluded that these rhythms are fundamental to photoperiodic timing. (C.H.)

17396 (BNL-7900) THE MECHANISM OF 5-AMINOURACIL INDUCED SYNCHRONY OF CELL DIVISION IN VICIA FABA ROOT MERISTEMS. Wolf Prensky and Harold H. Smith (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Cessation of mitosis was brought about in Vicia faba roots incubated for 24 hours in the thymine analogue, 5-aminouracil. Recovery of mitotic activity began 8 hours after removal from 5-aminouracil and reached a peak at 15 hours. If colchicine was added four hours before the peak of mitoses, up to 80% of all cells accumulated in mitotic division stages. By use of single and double labeling techniques, it was shown that synchrony of cell divisions resulted from depression in the rate of DNA synthesis by 5-aminouracil, which brought about an accumulation of cells in the S phase of the cell cycle. Treatment with 5-aminouracil may have also caused a delay in the rate of exit of cells from the G_2 period. It appeared to have no effect on the duration of the G_1 period. When roots were removed from 5-aminouracil, DNA synthesis resumed in all cells in the S phase. Although thymidine antagonized the effects of 5-aminouracil, an exogenous supply of it was not necessary for the resumption of DNA synthesis, as shown by incorporation studies with tritiated deoxycytidine. (auth)

17397 (BNL-7901) THE PRODUCTIVITY OF NATURAL COMMUNITIES. I. AN AUTOMATIC DATA RECORDING SYSTEM FOR MONITORING METABOLISM AND MICROCLIMATE IN THE FIELD. G. M. Woodwell, F. R. Becherer, and E. B. Hadley (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A system is described for measuring CO_2 exchange of leaves and stems of trees, ground cover, and soil and for recording these data and associated measurements of microclimate automatically on a punched tape. The system utilizes small, light chambers which are relatively simple to install and to maintain and which appear to minimize the environmental changes due to enclosure of the plant parts. The principal advantages of the system are that measurements can be made almost simultaneously at various points, recorded automatically, and the data can be handled entirely by machine. If sufficient descriptive data on the structure of the forest are available, the metabolism of the total system can be monitored on an hourly basis. One such set of measurements for an oak-pine forest on Long Island indicates that on a clear day in late July this forest fixed a net of 7600 mg of CO_2/m^2. (auth)

17398 (BNL-7916) IN VITRO DNA LABELING OF BONE MARROW AND LEUKEMIC BLOOD LEUKOCYTES WITH TRITIATED THYMIDINE. I. PHYSICAL AND CHEMICAL FACTORS WHICH AFFECT AUTORADIOGRAPHIC CELL LABELING. J. R. Rubini (Veterans Administration Hospital, Dallas, Tex.; Texas Univ., Dallas. Southwestern Medical School); S. Keller (Veterans Administration Hospital, Dallas, Tex.); and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Physical and chemical factors which affect cellular DNA labeling in vitro with ^{3}H-thymidine were evaluated using autoradiography. About 15 per cent of cells of normal dog bone marrow are capable of ^{3}H-DNA synthesis utilizing ^{3}H-thymidine. Cell labeling with ^{3}H-thymidine is temperature dependent with optimal labeling achieved near 37°C. At temperatures of physiological fever, cell labeling was not increased; at lower temperatures, ^{3}H-DNA synthesis appeared to be slowed down. Labeling of cells with ^{3}H-thymidine did not appear to require oxygen. Cell labeling required physiologic pH. Optimal cell labeling of dog marrow cell suspensions required 1 μC of high specific activity

^{3}H-thymidine. Under optimal conditions, adequate cell labeling can be achieved within exposure times of 7 to 14 days. Cell labeling with ^{3}H-thymidine is critically dependent upon specific activity of the label and the endogenous thymidine pool of tissues. The results are relevant to in vivo studies using ^{3}H-TDR. (auth)

17399 (BNL-7938) CRYSTAL AND MOLECULAR STRUCTURE OF TRIS-TRIPHENYLPHOSPHINE RHODIUM CARBONYL HYDRIDE. Sam J. LaPlaca and James A. Ibers (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The structure of tris-triphenylphosphine rhodium carbonyl hydride, $HRh(CO)(P(C_6H_5)_3)_3$, is of interest because the compound is representative of a small class of stable transition-metal hydrides and because it contains five-coordinated rhodium, the stereochemistry of which has not been studied previously. The compound crystallizes with four molecules in space group C_{2h}^5-$P2_1/n$ of the monoclinic system in a cell of dimensions a = 10.11, b(unique axis) = 33.31, c = 13.33 A, β = 90.0°. The structure has been solved by conventional three-dimensional Patterson, least-squares, and Fourier techniques. In order to make the refinement of this 60-atom problem feasible, the nine phenyl rings have been treated as groups and constrained to their well-known geometry. In a difference Fourier calculated after this refinement, the peak from the hydrogen atom attached to the rhodium is discernible. The conformation of the ligands around the rhodium atom is that of a trigonal bipyramid, with the three phosphorus atoms in the basal plane, the hydrogen at one apex, and the carbon of the carbonyl at the other. The rhodium atom lies 0.36 Å above the phosphorus plane toward the carbon of the carbonyl. The Rh-H distance is 1.60 ± 0.12 Å, a normal length for a covalent bond. (auth)

17400 (BNL-7939) EFFECTS OF INSULIN ON LIVER GLYCOGEN SYNTHESIS AND BREAKDOWN IN THE DOG. J. S. Bishop, R. Steele, N. Altszuler, A. Dunn, C. Bjerknes, and R. C. de Bodo (New York Univ., N. Y. Dept. of Pharmacology and Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Glucose-^{14}C was given intravenously in trace amount, as an initial dose followed by continuous infusion, to measure glucose-^{12}C release by the liver, and total glucose uptake from plasma by the tissues. The glycogen content of liver, and the ^{14}C incorporated into the glycogen and the non-glycogen constituents of liver were measured by analysis of percutaneous biopsy samples. Glucose-6-^{14}C was used to show that direct uptake and conversion to liver glycogen, without passage through three carbon intermediates, of tagged blood glucose molecules was the source of almost all the ^{14}C of glycogen. Insulin infusion, along with glucose to limit hypoglycemia, stopped glycogen loss, decreased glucose-^{12}C release, and brought about the incorporation of plasma glucose-^{14}C units into liver glycogen. Incorporation of ^{14}C into the non-glycogen constituents of the liver was increased much less. Total glucose uptake from plasma by the tissues was increased to 3.7 times the control rate. Glucose infusion, presumed to stimulate endogenous insulin secretion, produced similar effects. In earlier periods of insulin infusion the outstanding hepatic effects were decreases in glycogen loss and glucose-^{12}C release. In later periods the outstanding further effect was a great increase in the use of plasma glucose-^{14}C for liver glycogen synthesis. (auth)

17401 (BNL-7945) INHERITANCE OF ALKALOIDS IN INTROGRESSIVE HYBRIDS OF NICOTIANA. Harold H. Smith (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Chromatographic analyses of alkaloid content were made in two species of Nicotiana, N. langsdorffii and N. sanderae, the F_1 hybrid between them, and a number of reciprocal introgressive hybrids marked with genes from the nonrecurrent parent species. Observations were reported on the inheritance of three identified alkaloids (nicotine, nornicotine, and anabasine) and six unidentified alkaloids (U1–U6). No clear evidence of linkage was found between any of the marker genes and alkaloid content. The relation of such studies to problems of chemotaxonomy was briefly discussed. (auth)

17402 (BNL-7955) GRANULOCYTOPOIESIS. E. P. Cronkite and T. M. Fliedner (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 43p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Autoradiographic methods, using ^{3}H-thymidine and ^{32}PDF as tracers, were used in studies of granulocytopoiesis in man. Data are presented on the granulocytic cell renewal system, time parameters in granulocytic cell renewal, transit times through maturation and proliferation pools, the productive capacity of the bone marrow, and the regulation of granulocytopoiesis. (79 references.) (C.H.)

17403 (BNL-7961) FORMULATION OF A COMPARTMENTAL MODEL IN A STUDY OF PARTIAL PARATHYROID DEFICIENCY. S. H. Cohn, S. Bozzo, N. Glatstein, C. Constantinides, J. Litvak, and E. A. Gusmano (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A linear compartmental model based on ^{47}Ca tracer kinetic data was developed for use in studies of skeletal Ca metabolism in patients with suspected parathyroid insufficiency. Applications in diagnostic studies are described. (C.H.)

17404 (BNL-8819) FLOW PATTERNS AND RATES OF HUMAN ERYTHROPOIESIS AND GRANULOCYTOPOIESIS. E. P. Cronkite, T. M. Fliedner, P. Stryckmans, A. D. Chanana, J. Cuttner, and J. Ramos (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract [AT(30-2)-Gen-16]. 35p. (CONF-640805-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From International Society of Hematology Congress, Stockholm.

Autoradiographic methods, using ^{3}H-thymidine as a tracer, and serial cytological studies were used to determine flow patterns and rates of human erythropoiesis and granulocytopoiesis in individuals with normal hematopoietic tissues and those with pernicious anemia, polycythemia, myeloid metaplasia, myelofibrosis, and other pathological conditions. Data are presented on the progression of labeled cells through mitosis and across the boundary between proliferating and non-proliferating pools. (30 references.) (C.H.)

17405 (CONF-651-83) FAR-INFRARED IMPURITY MODES IN POTASSIUM IODIDE. Report No. 253. A. J. Sievers (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 1, 1964. Contract AT(30-1)-2179. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The effects of the impurities hydride, fluoride, chloride, bromide, sodium, silver, cesium, and thallium ions on the spectrum of pure KI were studied at 100 to 10 cm^{-1}. For silver ions, the impurity-induced absorption occurs above the T.A. branch, while for all the other impurities, absorption occurs above the T.A. branch but within the L.A. branch. The total absorption varies linearly with the impurity mass. (D.L.C.)

17406 (CONF-640807-1) STUDIES OF BOVINE LEUKEMIA IN MINNESOTA. D. K. Sorensen, R. K. Anderson, V. Perman, and J. H. Sautter (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). [1963]. Contract [AT(11-1)-410]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 3rd International Meeting on Diseases of Cattle, Copenhagen.

The occurrence and distribution of leukemia in cattle in the State of Minnesota and the relationship of environmental or familial factors to the occurrence of the disease was studied. Data are included from clinical, hematologic, and pathologic studies. (C.H.)

17407 (COO-1148-94) INORGANIC POLAROGRAPHY IN ORGANIC SOLVENTS. Reiji Takahashi (Michigan Univ., Ann Arbor). Jan. 20, 1965. Contract AT(11-1)-1148. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The polarographic behavior of inorganic species in organic solvents is reviewed with particular attention to the theoretical principles involved in comparing the behavior of inorganic species in organic solvents with their behavior in aqueous media. Polarography of different inorganic species in a specific solvent is discussed with stress on reference electrode and potential measurement, and the factors affecting half-wave potential and diffusion current. Polarographic data obtained in different solvents are considered primarily on the basis of the problems involved in determining comparable potential values in different solvents and in comparing half-wave potentials and limiting diffusion currents. Finally, the analytical aspects of the polarography of inorganic species in organic solvents are summarized. (auth)

17408 (COO-1197-9) SELF-DIFFUSION OF THE SODIUM ION IN PURE SODIUM CHLORIDE. Harry L. Downing, Jr. (Kansas Univ., Lawrence). June 1964. Contract AT(11-1)-1197. 64p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The diffusion coefficients D_0 and D(Na) were determined in NaCl in the high-temperature, intrinsic region by means of electric conductivity and ^{22}Na tracer measurements, respectively. The conductivity was found to vary with time, while the diffusion data were consistent. The fact that the total diffusion coefficient D = D(Na) + D(Cl) lies above D_0 on the log D vs 1/T graph, indicates a possible vacancy pair contribution to the diffusion. (D.L.C.)

17409 (COO-1197-10) POLARIZED ABSORPTION MEASUREMENTS OF SODIUM CHLORIDE WITH CALCIUM IMPURITY. Dennis E. Lauer (Kansas Univ., Lawrence). Aug. 1964. Contract AT(11-1)-1197. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A study was made of the possible dichroic effect in the bleaching of impurity-induced color centers in Ca-doped NaCl. The crystals were colored by x-irradiation at room temperature, and then optical measurements were made at liquid nitrogen temperature. Bleachings were carried out at room temperature. No dichroic effect was found, and possible reasons for this observation are discussed. (D.L.C.)

17410 (HW-SA-3359) BIRD SURVEYS IN COTTONWOOD-WILLOW COMMUNITIES IN WINTER. W. H. Rickard (General Electric Co., Richland, Wash.). Hanford Atomic Products Operation. Feb. 10, 1964. Contract AT-(45-1)-1350. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Bird surveys were made in four winter seasons in cottonwood-willow streamside communities in New Mexico and Washington. More bird species were observed in New Mexico than in Washington. The greater number of species observed in the New Mexico habitat was attributed to bird visitants from adjacent coniferous forest and scrub vegetation rather than to an ameliorated winter climate. Oregon Juncos were abundant birds in both communities. Other species occurring in both communities were the Black-billed Magpie, Red-shafted Flicker, Song Sparrow, Downy Woodpecker, House Finch and Ruby-crowned Kinglet. (auth)

17411 (IAEA-2616) PHOSPHATE METABOLISM OF ESCHERICHIA COLI. Final Report, September 1, 1961–May 14, 1964. Leiv Klungsoeyr (Bergen Univ. (Norway). Dept. of Pharmacology). Contract IAEA 65/R1/US. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The metabolism of carbohydrate-phosphate compounds in Escherichia coli was studied with the aid of ^{32}P and ^{14}C labelled compounds, and enzymatic methods. The main findings are briefly summarized. (C.H.)

17412 (MLM-1163) SYMPOSIUM ON RESEARCH AT MOUND LABORATORY, JUNE 6-7, 1963. R. A. Benson, ed. (Mound Lab., Miamisburg, Ohio). Contract AT-33-1-GEN-53. 157p. (CONF-630601). Dep.; $5.00(cy), 3(mn) CFSTI.

Sixteen papers are included on unclassified research at Mound Laboratory. Topics considered are thermal diffusion, isotope separation, polonium, plutonium systems, phase equilibria, molten alloys, plutonium-bearing glasses, etc. Separate abstracts were prepared for 14 of the papers. For abstracts of the other two papers, see NSA 17: 32467 and 18: 24127. (D.L.C.)

For abstracts of individual papers see: 15347, 15348, 15414, 15826, 15973, 15974, 16000, 16030, 16073, 16074, 16075, 16256, 16257, and 16849.

17413 (NP-14684) PROJECT CHARIOT AND THE ESKIMO PEOPLE OF POINT HOPE, ALASKA. Don Charles Foote. Mar. 1961. 25p.

The use of the Cape Thompson region by Alaskan Eskimos as a source of food is described. The possible effects of nuclear detonations of Project Chariot on food supplies and the possible psychological effects of the detonations on the Eskimos are discussed. (C.H.)

17414 (NVO-98-3) FINAL PROGRESS REPORT. TASK II. (National Marine Consultants. Div. of Interstate Electronics Corp., Anaheim, Calif.). Dec. 1964. Contract AT(26-1)-98. 93p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The design, fabrication, and checkout of two deep ocean buoy systems and the design of two wave gages applicable to atoll and island wave measurements are described. Operation procedures for the Quicklook Subsystem, which is part of the Tsunami Wave Measurement System, are given. The Quicklook Subsystem is designed to provide a strip chart analog output of digital data recorded on magnetic tape by the Data Logging System. (N.W.R.)

17415 (NVO-98-4) FINAL PROGRESS REPORT, TASK III. (National Marine Consultants. Div. of Interstate Electronics Corp., Anaheim, Calif.). Dec. 1964. Contract AT(26-1)-98. 67p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Testing of the deep water platforms and sensors in local waters and testing of a prototype system in mid-pacific deep water for measurement of tsunami waves are reported. With the problems of the platform instrumentation resolved after the San Clemente Island tests the taut-line buoy system's electrical and upper mechanical problems were under control. Testing in the mid-pacific area involved establishing a method for handling and implanting the system as much as it was to evaluate the system once it was implanted. The weight handling procedure was a major task in itself for only on the third attempt was success attained. The deep water mooring tests aided in finding flaws in the taut-line buoy system but with these being of minor magnitude and with only minor modifications being required to the system, it can be said that it operated as per design. (N.W.R.)

17416 (NYO-3105-1) BIOCHEMISTRY OF GAMETOGENESIS AND FERTILIZATION IN ALGAE. Final Report. Raymond F. Jones (Princeton Univ., N. J. Dept. of Biology). Jan. 29, 1965. Contract AT(30-1)-3105. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The life cycle of the algae, chlamydomonas, is discussed with emphasis on the biochemistry of gametogenesis and fertilization. (C.H.)

17417 (NYO-3217-1) MICROCATALYTIC BENZENE HYDROGENATION STUDIES ON TRANSITION METAL-GROUP Ib METAL ALLOYS. Technical Progress Report. D. A. Cadenhead (State Univ. of New York, Buffalo). Feb. 22, 1965. Contract AT(30-1)-3217. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A microcatalytic study of the hydrogenation of benzene was carried out over palladium, palladium–copper, palladium–gold, and palladium–silver alloys. A microcatalytic technique was chosen because of the poisoning effect of hydrogen on palladium with prolonged exposure. Reproducible activity was found for palladium and palladium-rich alloys over a temperature range 50-150°C. Unlike previous work reported, and confirmed by measurements on copper-nickel alloys, no maximum was found in the specific activity versus composition plots at any temperature. Nor did

the apparent activation energy or frequency factor show a similar maximum. These results are interpreted in terms of a theory which stresses the importance of the mode of chemisorption of the benzene molecule on the metal surface on the variation of the kinetic parameters, and presents a modified picture of the nature of sorbed films at metal alloy-gaseous interfaces. The theory enables the prediction of the activity and activation energy for other transition metal-group Ib alloys in the hydrogenation of benzene. (auth)

17418 (ORNL-P-815) REFINEMENT OF THE STRUCTURE OF α-D-GLUCOSE FROM NEUTRON DIFFRACTION DATA. George M. Brown and Henri A. Levy (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 3p. (CONF-650202-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Crystallographic Assn., Suffern, N. Y.

Intensity data were measured for a crystal, corrected for absorption, and used in least-squares refinement. The atomic coordinates and their least-squares errors are listed. Bond lengths and angles are shown in a diagram of the α-D-glucose molecule. (D.L.C.)

17419 (ORNL-TM-1037) SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS WITH THE 1604 SUBROUTINE MATQ. C. W. Nestor, Jr. (Oak Ridge National Lab., Tenn.). Jan. 15, 1965. Contract W-7405-eng-26. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The matrix equations $A x = b$, $A^2 x = Ab$ and $A^3 x = A^2 b$ were solved for the solution vector x with a matrix A having elements $a_{ij} = 2$ for $i = j$, $a_{ij} = -1$ if $|i - j| = 1$ and zero otherwise. The elements of the right hand side vectors b, Ab and A^2b were set equal to the corresponding row sums of A, A^2 and A^3, so that the solution vector x in each case would have all $x_j = 1$. The order of the matrices ranged from 3 to 30. These calculations were repeated on the 1604 using the Gaussian elimination subroutine MATQ. In general, the maximum error in the solution vector was about 10^{-3} times the corresponding 7090 result, consistent with the larger number of bits in the 1604 word. In contrast to the 7090 results, close correspondence was observed between the growth of the maximum error and the P condition number for the A^2 and A^3 matrices. The departure of the error behavior of the A matrix from that expected could be interpreted as owing to the discrete nature of the error. (auth)

17420 (PNE-440) THE ECONOMIC BASE AND SEASONAL ACTIVITIES OF SOME NORTHWEST ALASKAN VILLAGES. A Preliminary Study. Don Charles Foote Nov. 1959. Contract AT(04-3)-315. 59p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The economic status of Eskimos of northwest Alaska is discussed. Seasonal activities are described, with emphasis on hunting. (C.H.)

17421 (PNE-441) THE ESKIMO HUNTER AT POINT HOPE, ALASKA, SEPTEMBER 1959 TO MAY 1960. Don Charles Foote. June 1960. Contract AT(04-3)-315. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The relation of hunting activities to the meat supply of Eskimos of northwest Alaska is discussed. (C.H.)

17422 (PNE-442) THE ESKIMO HUNTER AT POINT HOPE, ALASKA. PART II. MAY TO SEPTEMBER 1960. Don Charles Foote. Dec. 1960. Contract AT(04-3)-315. 26p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The most important activity of Point Hope, during late spring and after the conclusion of intense whale hunting, is the harvest of marine mammals; seals, and oogruk. Before the June migration of seals begins, the village can be heavily dependent upon caribou meat secured from February through April and into May, the catch of migrating spring birds and a seal population resident in the winter ice to the north and south of the Tigaraq Peninsula. Should the early spring whale hunt fail and contrary winds dislodge the late spring ice south of the Tigaraq Peninsula, Point Hope would suffer a food shortage alleviated only by caribou meat obtained in late-winter-spring, and by eggs, birds, caribou, and fish taken during the summer. Summer employment, although necessary, does not prevent the village of Point Hope from reaping an equally necessary harvest of spring seals, birds, eggs, summer caribou, and fish. Food gathering during the summer is focused on the bird cliffs and adjacent highlands and valleys of Cape Lisburne and Cape Thompson, and the Kukpuk River drainage as far as Kaiaksuk-Anmarox Mountains depending upon the level of river water. In all events, summer travel and hunting routes are associated with water; the more accessible areas being the Kukpuk River and the Cape Thompson highlands. Summer hunting by Point Hope residents in the immediate vicinity of Augotoruk Creek was at a minimum in 1960 because of the extensive activity of the resident Project Chariot camp personnel. Augotorux Creek is, however, a traditional summer hunting ground for the Point Hope Eskimos. Any sign of reduced use of the area during the 1960 summer can be attributed to, beside the already mentioned restraints of wind and other natural phenomena, the presence of large-scale air and mechanized land traffic, noise, smells and other features of the Chariot site which would prevent a normal number of game animals from frequenting the mouth of the Augotorux Creek. The loss of this region as a summer hunting area cannot be determined quantitatively since there are no statistics available prior to commencement of Project Chariot operations in the creek bottom. It is obvious that the year around Point Hope hunters, of necessity, reap a rich harvest from their land and sea whenever and wherever the natural conditions of weather, topography, and the occurrence of animals allows them. (auth)

17423 (PNE-443) THE ESKIMO HUNTER AT NOATAK, ALASKA, WINTER 1960. Don Charles Foote. SUMMER 1960. Alan Cooke. Dec. 1960. Contract AT(04-3)-315. 64p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The economic status, diet, health, and education of Eskimos of northwest Alaska are described. Emphasis is placed on the relation of hunting activities to economic conditions. (C.H.)

17424 (PNE-444) A HUMAN GEOGRAPHICAL STUDY IN NORTHWEST ALASKA. Final Report. Don Charles Foote. June 1961. Project Chariot. Contract AT(04-3)-315. 157p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Contemporary life is described for the Eskimo people of northwest Alaska who inhabit the region limited on the north by Point Loy, on the south by Kotzebue, and on the east by Howard Pass. Historical information on the Eskimos is presented and the economy, geology, ecology, and meteorological features of the region are described. (102 references.) (C.H.)

17425 (RFP-480) THE ALPHA ANGLE ADJUSTER. A. S. Kaminski, J. H. Maytag, and D. J. McPhee (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Feb. 3, 1965. Contract AT(29-1)-1106. 11p. Dep.; $0.50(cy), 1(mn) CFSTI.

A device called the Alpha Angle Adjuster has been developed that enables linear measurements to be made perpendicular to almost any curved surface. (auth)

17426 (SC-R-65-851) PULSE STRENGTH OF HIGH POLYMERS. O. Milton, J. B. Allyn, L. J. Seligman, and J. L. Wentz (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract [AT(29-1)-789]. 21p. (CONF-695-3). Dep.; $1.00(cy), 1(mn) CFSTI.

From EIVR-10 Atomic Weapons Research Establishment Meeting, Aldermaston, Berks, Eng., Oct. 1964.

Force fields from a 20 μsec electrical pulse and a cylindrical shock front obtained from an exploded wire were applied to high polymers to study mechanism of breakdown and intrinsic strength. Preliminary results indicate that an inverse relationship exists between mechanical pulse strength and electrical pulse strength, that a filler improves electrical pulse resistance of an epoxy resin, and that the intrinsic electrical strength of an epoxy resin is at least 8×10^6 v/cm. (auth)

17427 (SC-TM-8-62(51)) WIND MEASUREMENT FOR DIGITAL RECORDING. J. W. Reed (Sandia Corp., Albuquerque, N. Mex.). [nd]. Contract [AT(29-1)-789]. 9p. (CONF-789-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 1964.

Vector wind data observed in polar coordinates, which are to be transformed into Cartesian coordinates, are treated to give more accuracy after round-off than is obtained by uniformly dividing the quadrant into angular segments for which sine and cosine are computed. The oscillating nature of round-off errors in computing trigonometric functions must be considered in designing digital encoding systems. An optimized five binary digit transmission system is shown, which will report Cartesian component winds, accurate to 8%, when activated by a digital wind speed sensor. (auth)

17428 (TID-20451) IDENTIFICATION OF ANIONIC COMPLEXES IN AQUEOUS SOLUTION BY SOLVENT EXTRACTION USING LONG-CHAIN AMINES. A. S. Kertes, P. J. Lloyd, K. Kimura, J. F. Byrum, and J. W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science and Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry). Apr. 3, 1964. Contract AT(30-1)-905. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A criticism is presented of the use of distribution data in amine salts to identify anionic complexes in aqueous solutions. A metal may be extracted as a neutral species as well as an anionic complex, and the fact that a cation tends to form anionic complexes in the organic phase does not necessarily mean that such complexes must exist in the aqueous phase. The diluent is shown to exert a large effect on the slope of the log E vs log [extractant] plot for uranyl nitrate, although all the organic phases show the spectrum of $UO_2(NO_3)_3^-$. Similarly, for various trivalent metal chlorides with tridodecylamine hydrochloride, the plots indicate the existence of MCl_6^{3-} anions, while other studies show MCl_4^-. It is suggested that the disagreement may be caused by an unknown state of the amine solute in the organic phase. (D.L.C.)

17429 (TID-20520) LIPID METABOLISM IN HUMAN LEUCOCYTES IN VITRO. I. BIOSYNTHESIS AND METABOLIC UTILIZATION OF LONG CHAIN FATTY ACIDS. C. J. Miras, J. D. Mantzos, and G. M. Levis (Athens Univ. (Greece). Dept. of Clinical Therapeutics). [1964]. Contract AT(30-1)-2769. 39p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Purified human leukocytes were incubated with ^{14}C-acetate, the lipids extracted, and separated by silicic acid column chromatography into cholesterol esters, plus hydrocarbons, neutral lipids, polyglycerol phosphatide, glycolipids, phosphatidyl serine plus phosphatidylethanolamine, phosphatidyl choline, and sphingomyelin. Analyses of the fractions and autoradiograms of thin layer chromatograms are presented. The data are discussed in terms of the biosynthesis and metabolic utilization of long chain fatty acids by leukocytes. (54 references.) (C.H.)

17430 (TID-21412) STABILITIES OF COORDINATION COMPOUNDS. Progress Report, September 1, 1960–August 31, 1961. (Pennsylvania State Univ., University Park. Dept. of Chemistry). Contract AT(30-1)-907. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Metal-amine compounds involving tris(2-aminoethyl)-amine, tris(3-aminopropyl)amine, and 1(2'-aminoethyl)-piperazine were studied. Formation constants and structures of these chelates are discussed along with determination of errors in stability constants. (J.R.D.)

17431 (TID-21497) THE EFFECT OF PARATHYROID HORMONE ON CARBOHYDRATE METABOLISM. Final Report. (Loyola Univ., Chicago, Ill.). [1964]. Contract AT-(11-1)-955. 48p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The influence of parathyroid hormone on the metabolism of several intermediates of the Kreb's cycle by the kidney was studied. Homogenates of kidneys from control rats and from rats pretreated with parathyroid hormone were incubated with carbon-14 labeled substrates in sealed Warburg vessels. The substrates included glucose-1-^{14}C, acetate-1-^{14}C, succinate-2,3-^{14}C and citrate-1,5-^{14}C. The incubations were stopped with trichloroacetic acid and the radioactive carbon dioxide evolved was quantitatively collected and analyzed for both total and specific activity. The radioactive organic acids of the Kreb's cycle, arising from the metabolism of the carbon-14 labeled substrates were separated and identified by column chromatography on Celite 535. Their identity was confirmed by paper chromatography and chemical analysis. The parathyroid hormone was shown to have an effect on the utilization of acetate-1-^{14}C and citrate-1,5-^{14}C by the kidney. The utilization of succinate-1-^{14}C and citrate-1,5-^{14}C by the kidney. The utilization of succinate-2,3-^{14}C and glucose-1-^{14}C by the kidneys of parathyroid hormone treated rats was only slightly different from that of the control animals. When the homogenates were incubated with acetate-1-^{14}C and citrate-1,5-^{14}C, those from the parathyroid hormone-treated rats evolved less radioactive carbon dioxide than did the control kidney homogenates. Similarly, the radioactive organic acid profiles of the kidney homogenates revealed gross differences between controls and experimentals after incubation with these substrates. There was significantly more acetate-1-^{14}C and citrate-1,5-^{14}C remaining in the experimental incubations than in the controls. In addition, the amount of activity incorporated into the organic acids of the Kreb's cycle was greater in the experimental kidneys than in the control kidneys for both substrates, in spite of the decreased utilization of these substrates. The results supported the findings of other investigators that the parathyroid hormone has a direct effect on the kidney. The evidence suggested that part of this effect is a result of an inhibition of oxidation of substrates of the Kreb's cycle in this tissue. When these studies were continued and extended it was found that the parathyroid status of rats had no significant effect on the rate of citrate oxidation by both kidney homogenates and mitochondria. Neither the amount nor the pattern of $^{14}CO_2$ release nor the distribution of the label in the Kreb's cycle from the incubation mixtures was influenced by parathyroid hormone. Varying the labeled citrate concentration, the specific activity of the citrate the osmolarity and the pH of the incubation medium did not reveal any significant differences between the hormone treated and the untreated animals in the matter of citrate oxidation by kidney tissue. (C.H.)

17432 (TID-21515) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. III. VEGETATION OF NEOTOMA. Final Report. Jerry A. Koch (Ohio State Univ., Columbus. Dept. of Botany and Plant Pathology and Ohio Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 137p. Dep.(mn); $4.00(cy), 4(mn) CFSTI.

Results are reported from a detailed study of the vegetation of the 150-acre Neotoma Valley, Ohio. (C.H.)

17433 (UCRL-11002) TOPOTAXY IN THE ANATASE-RUTILE TRANSFORMATION. Robert D. Shannon and Joseph A. Pask (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 30, 1964. Contract W-7405-eng-48. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Oriented phase transformations are considered to be cases of topotaxy. The anatase-rutile transformation has been shown to result in preferred orientation of the product and is, therefore, classified as a case of intermediate topotaxy. Single crystals of anatase were transformed to rutile at temperatures of 900–950°C. The resulting rutile crystallites were found to exhibit preferred orientation which was studied by means of oscillation photographs. Interpretation of the resultant pole figures led to a mechanism of transformation which was similar to that of the brookite-rutile transformation. The mechanism involves retention of the {112} pseudo-close-packed planes in anatase and rearrangement of the titanium and oxygen ions within the plane. A cooperative movement of the titanium and oxygen ions is proposed in which the majority of the

titanium ions, in order to reach their new sites, break two of their original six Ti-O bonds. (auth)

17434 (UCRL-11683) MOLECULAR REGULATION AND ITS POSSIBLE EVOLUTIONARY SIGNIFICANCE. V. Moses and M. Calvin (Lawrence Radiation Lab., Univ. of California, Berkeley). Sept. 1964. Contract W-7405-eng-48. 45p. (CONF-640906-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Evolving Genes and Proteins, New Brunswick, N. J.

Results are reported from studies of enzyme synthesis by Escherichia coli and B. subtilis under a number of environmental and nutritional conditions. Emphasis was placed on the synthesis of enzyme mRNA, total DNA, and protein with and without 6-azauracil, an RNA inhibitor. Results indicate that mRNA for inducible enzymes is labile and that for constitutive enzymes is stable. It is suggested that the high rates of formation and decay of inducible messenger gives the cell a means of responding very sensitively to environmental changes by adopting its content of enzymes. The evolutionary consequences of differential mRNA stability are discussed. (C.H.)

17435 (UCRL-11863) STUDIES ON THE STRUCTURE AND PHOTOCHEMISTRY OF CHLOROPLAST LAMELLAE (thesis). John Biggins (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 150p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A study was made of the molecular structure of the chloroplast lamellae using biochemical techniques and of the photochemical properties of reactions that occur during photosynthetic electron transport in the lamellae. Emphasis was placed on quantum efficiencies and wavelength dependences of the reactions in order to further characterize the pigment systems responsible for quantum conversion. Results are reported from studies using chloroplast lamellae from Spinacia oleracea. (165 references) (C.H.)

17436 (UCRL-12225-T) VAPOR SPECIES OF THE BARIUM–OXYGEN–HYDROGEN SYSTEM (thesis). Ray Selmer Newbury (California. Univ., (Berkeley. Dept. of Mineral Technology and California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 16, 1964. Contract W-7405-eng-48. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Mass spectrometric and vacuum thermobalance measurements made on barium oxide between 1365 and 1917°K established that the pressure of the principal gaseous species, $BaO_{(g)}$, can be represented by the expression in $P_{atm} = -52,080/T + 18.19$ within that temperature range. The enthalpy for the reaction $BaO_{(s)} = BaO_{(g)}$ was calculated to be $\Delta H^{\circ}_{298} = 110.9 \pm 2.8$ kcal/mole by the second law method and $\Delta H^{\circ}_{298} = 110.4 \pm 0.7$ kcal/mole by the third law method, assuming the existence of the $^3\pi$ state at or near (within a few hundred cm^{-1}) the ground state of $BaO_{(g)}$. Small amounts of Ba_2O^+ and $Ba_2O_2^+$ were observed in the mass spectrometer. $\Delta H^{\circ}_{800} \cong 142$ kcal/mole for the reaction $2BaO_{(s)} = Ba_2O_{2(g)}$. ΔH°_{800} was estimated to be 204 kcal/mole for the reaction $2BaO_{(s)} = Ba_2O_{(g)} + \frac{1}{2} O_{2(g)}$. No reaction between barium oxide at 1800°K and $O_{2(g)}$ at pressures up to 10^{-3} atmospheres was detected. Barium oxide was found to react with water vapor to form $Ba(OH)_{2(g)}$. The equilibrium constant for the reaction $BaO_{(s)} + H_2O_{(g)} = Ba(OH)_{2(g)}$ from 1428 to 1899°K can be represented by $\ln K = -18,700/T + 5.61$. The enthalpy for the dihydroxide reaction was calculated by the second law to be $\Delta H^{\circ}_{298} = 41,500 \pm 1,200$ cal/mole, and by the third law, $\Delta H^{\circ}_{298} = 41,000 \pm 1,500$ cal/mole. The reaction $BaO_{(s)} + \frac{1}{2} H_{2(g)} = BaOH_{(g)}$ was observed at 1851°K, for which ΔH°_{1851} is estimated to be 84.5 kcal/mole and $\ln K = -42,500/T + 13.9$ near 1850°K. (auth)

17437 (UCRL-13141) ENGINEERING DEVELOPMENT AND FABRICATION OF TYPE MC(L-) LONG WET-LIFE BATTERIES. Final Technical Report, November 8, 1963–August 15, 1964. (Electrochimica Corp., Menlo Park, Calif.). Contract [W-7405-eng-48]. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Presented are the tasks accomplished in this program for engineering development and manufacture of 800, 0.7 ampere-hour cells, and 800, 2.5 ampere-hour cells of mercuric oxide-cadmium battery system. Of the 800, 2.5 ampere-hour cells, 35 eight-cell batteries were fabricated by connecting the cells in series and encapsulating the group. The engineering development phase is described, and complete detail material and process specifications and drawings are presented for all components and subassemblies. In addition, inspection procedures were prepared to coincide with the process inspection and to provide for inspection from raw materials to final product stage. Results of quality control tests are given. The discussion of the program includes comments on future possible aspects. (auth)

17438 (WAPD-T-1479) STABILITY OF A MULTIPLICATIVE STOCHASTIC PROCESS WITH LINEAR FEEDBACK (thesis). Donald John Dudziak (Pittsburgh Univ., Pa.). Mar. 1963. Contract [AT(11-1)-Gen-14]. 100p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Four particular models of a generalized birth and death process are chosen for study of their stability. Four models are specified. Stability of solutions to the forward stochastic equation to the Kolmogorov equations is defined in terms of honesty of the solutions, ergodic properties (e.g., existence of a long-run distribution), recurrence times, and first passage times. (C.E.S.)

17439 THE NUCLEAR ENERGY PROGRAMS IN THE USA, GREAT BRITAIN, AND FRANCE. Klaus-Dieter Fischer (Universitat, Cologne). At. Strom, 10: 97-101 (Nov. 1964). (In German)

The nuclear energy programs of the USA, Great Britain, and France are briefly reviewed, with a consideration of the aims of each program and the future place of nuclear energy in the production of the electrical power. (J.S.R.)

17440 NUCLEONICS IN ROCKETRY AND SPACE TECHNOLOGY. P. Wilkniss and A. Moghissi (Naval Propellant Plant Research and Development Dept., Indian Head, Md.). Atompraxis, 11: 13-20(Jan. 1965).

A review of the nucleonics literature as it relates to rocketry and space technology is presented. Publications in this field of nuclear propulsion, nuclear auxiliary power, nuclear instrumentation, nondestructive testing, radiation effects, and radioactive tracer techniques are included. 259 references are cited. (auth)

17441 THE ROLE OF THE ENGINEER IN THE PROVISION OF RAW MATERIALS FOR THE NUCLEAR POWER INDUSTRY — PAST, PRESENT AND FUTURE. R. E. Robinson. "Easa" (J. Engrs.' Assoc. (S. Africa)), 21: 13-29(Jan.-Feb. 1964).

The importance of economics in the nuclear power industry is discussed. The relative importance of the cost of fuel in a number of reactor systems is shown in relation to other costs. Development of the South African uranium industry is described. The two major engineering problems were the handling of vast tonnages of abrasive, high-density slurries and the problem of corrosion. Research projects on raw materials, uranium extraction, solvent extraction processes, resin development in pulp processes, pressure leaching, development of a mine shaft autoclave, studies of cladding materials, preparation of nuclear raw materials in South Africa, and the role of the engineer in future development of nuclear power are discussed. (M.C.G.)

17442 KARLSRUHE NUCLEAR RESEARCH CENTRE (GESELLSCHAFT FUR KERNFORSHUNG mbH.). Euro Nucl., 2: 41-8(Jan. 1965).

The Karlsruhe Nuclear Research Center and its organization are described. The fast breeder project, research on transuranium elements, reactor development, cyclotron, pulsed generator, direct generator, linear accelerator, pulsed neutron sources, research on neutron physics and reactor engineering, nuclear engineering studies, developments in applied and experimental physics, isotope techniques development, operation of the cyclotron laboratory,

studies in radiochemistry, food preservation research, radiobiological studies, and technological developments are discussed. (M.C.G.)

17443 IRON ALLOY. Donald B. Roach, Dimon A. Roberts, and Albert M. Hall (to U. S. Atomic Energy Commission). U. S. Patent 3,170,824. Feb. 23, 1965.

A ductile iron alloy containing from 13 to 18 wt % manganese, from 7 to 11 wt % nickel, from 1.1 to 0.95 wt % of carbon and up to 1 wt % silicon was prepared, annealed at about 1100°C, and water-quenched. (AEC)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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422596	19-16263	See USCEC-82-212
422953	19-17264	
422962	19-17071	See AFCRL-63-377
423051	19-15009	See AMRNL-279
423411	19-17351	See RTD-TDR-63-3054
423426	19-15701	See USCEC-82-214
423713	19-16449	See TRW-ER-5632
424203	19-16031	See SSD-TDR-63-196
424622	19-16053	
424694	19-15776	$1.10(CFSTI)
425058	19-16024	$8.60(CFSTI)
425214	19-15019	See RRA-N318
425218	19-16025	$9.10(CFSTI)
425407	19-17350	See RTD-TDR-63-3002
455346	19-16764	See AROD-3473:2
602730	19-15700	See ATD-P-64-46
603599	19-16728	$4.00(CFSTI)
603602	19-16248	$4.00(CFSTI)
603609	19-17360	See GNE/Phys/64-3
603685	19-17070	$3.00(CFSTI)
604997	19-16439	$2.00(CFSTI)
605127	19-16857	See P-996(RAND)
605265	19-16255	See ML-1146
605430	19-15561	$1.00(CFSTI)
605532	19-16251	See AFOSR-64-1647
607563	19-15023	For translation see FTD-TT-64-644
609051	19-16444	See AFAPL-TR-64-135
609177	19-16440	$4.00(CFSTI)
AE–	**(Non-AEC)**	
168	19-15333	Dep.(mn)
169	19-15334	Dep.(mn)
172	19-15335	Dep.(mn)
63-0138	19-17350	See RTD-TDR-63-3002
AEC-tr–		
6537	19-16005	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL
6541	19-16032	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL
6543	19-15673	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL
AECL–	**(Canadian)**	
2114	19-15777	Dep.; $1.00(AECL)
2123	19-15778	Dep.; $1.00(AECL)
2138	19-16207	Dep.; $0.50(AECL)
2146	19-15824	See CRC-1211
2164	19-15342	See DCI-52
AEET-CD–	**(Indian)**	
27	19-16054	Dep.(mn)
AEET-HP–	**(Indian)**	
Th-2	19-15779	Dep.(mn)
Th-9	19-16466	Dep.(mn)
Th-18	19-17212	Dep.(mn)
TM-11	19-17356	Dep.(mn)
AEET-Met.–	**(Indian)**	
2	19-16055	Dep.(mn)
3	19-16056	Dep.(mn)
AEET-NP–	**(Indian)**	
9	19-16835	Dep.(mn)
11	19-15765	Dep.(mn)
AEET-Spec.–	**(Indian)**	
2	19-15821	Dep.(mn)
3	19-15336	Dep.(mn)
4	19-15337	Dep.(mn)
6	19-15338	Dep.(mn)
7	19-15339	Dep.(mn)
AEEW-M–	**(British)**	
490	19-17213	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
AERE-M–	**(British)**	
1398	19-16443	Dep.(mn)
1515	19-15822	Dep.
AERE-R–	**(British)**	
4451	19-15889	J. Nucl. Energy, Pt.A and B, 19: 17-31(1965)
4776	19-16814	Dep.; $1.80(BIS); 9s. (HMSO)
4792	19-17390	Dep.; $1.60(BIS); 8s. (HMSO)
4820	19-16011	Dep.; $1.40(BIS); 7s. (HMSO)
4838	19-15562	Dep.; $1.00(BIS); 5s. (HMSO)
AERE-TP–	**(British)**	
153	19-16933	Nucl. Phys., 66: 241-60(1965)
AFAPL-TR–	**(Non-AEC)**	
64-135	19-16444	$7.00(CFSTI)
AFCRL–	**(Non-AEC)**	
63-345	19-16263	See USCEC-82-212
63-347	19-15701	See USCEC-82-214
63-377	19-17071	$9.10(CFSTI)
64-1018	19-15661	
AFML-TR–	**(Non-AEC)**	
64-353	19-15563	
64-362	19-15989	
AFOSR–	**(Misc.)**	
64-1647	19-16251	$1.00(CFSTI)
AGARDograph–	**(Non-AEC)**	
84	19-16294	See CONF-752(Pt.II)
AGN–	**(Misc.)**	
8131	19-16057	Dep.(mn); $2.00(cy), 1(mn) CFSTI
Al–	**(Misc.)**	
64-5	19-16058	
Al-Trans–		
73	19-16224	Dep.(mn); $1.60(fs), $0.80(mf) JCL
AMF–		
338-TR-4	19-17265	Dep.(mn); $6.00(cy), 5(mn) CFSTI
AMRNL–	**(Non-AEC)**	
279	19-15009	$8.60(CFSTI)
ANL–		
6778	19-17357	Dep.; $2.00(cy), 1(mn) CFSTI

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6861	19-15711	Dep.; $5.00(CFSTI)
6897	19-15853	Dep.; $2.00(cy), 1(mn) CFSTI
6900	19-15330	Dep.; $7.00(cy), 6(mn) CFSTI
6915	19-17358	Dep.; $2.00(cy), 1(mn) CFSTI
6926	19-17266	Dep.; $2.00(cy), 1(mn) CFSTI
6952	19-15978	Dep.; $4.00(cy), 2(mn) CFSTI
6965	19-17175	Dep.; $4.00(CFSTI)
ANL-Trans–		
33	19-15420	Dep.; $7.00(cy), 6(mn) CFSTI
APDA–	(Misc.)	
166	19-15340	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ARL–	(Non-AEC)	
64-220	19-17072	CFSTI
AROD–	(Misc.)	
3473:2	19-16764	
4434:2	19-16060	
ATD-P–	(Non-AEC)	
64-46	19-15700	$3.00(CFSTI)
AWRE-O–	(British)	
7/65	19-15748	Dep.(mn); $0.50(BIS); 2s. 6d. (HMSO)
11/65	19-15749	Dep.(mn); $0.30(BIS); 1s. 2d. (HMSO)
BAW–	(Misc.)	
1280-18	19-15712	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3125-3	19-16838	Dep.(mn); $1.00(cy), 1(mn) CFSTI
BBC-TR–	(Non-AEC)	
382-243	19-16026	
BDX–		
613-39	19-17391	Dep.(mn); $2.00(cy), 1(mn) CFSTI
613-43	19-17392	Dep.(mn); $1.00(cy), 1(mn) CFSTI
613-56	19-17393	Dep.(mn); $1.00(cy), 1(mn) CFSTI
BM-RI–	(Misc.)	
6601	19-15664	Free(Bureau of Mines)
BMI–	(Misc.)	
1708	19-15990	Dep.; $1.75(cy), 2(mn) CFSTI
1709	19-15972	Dep.; $1.00(cy), 2(mn) CFSTI
1713	19-15564	Dep.; $0.75(cy), 1(mn) CFSTI
BMI-X–		
329	19-16012	Dep.(mn); $1.00(cy), 1(mn) CFSTI
10113	19-16061	Dep.(mn); $2.00(cy), 1(mn) CFSTI
BNL–		
841	19-17394	Dep.; $4.00(cy), 2(mn) CFSTI
6680	19-15211	p.238-50 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964
7815	19-15010	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7859	19-14953	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7860	19-17395	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7869	19-15165	Radiation Botany, 4: 417-27(1964)
7890	19-15011	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7898	19-15012	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7900	19-17396	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7901	19-17397	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7916	19-17398	$2.00(cy), 1(mn) CFSTI
7917	19-14954	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7938	19-17399	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7939	19-17400	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7945	19-17401	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7955	19-17402	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7961	19-17403	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7981	19-16690	J. Chem. Phys., 41: 1879-80(1964)
8078	19-17013	Rev. Mod. Phys., 36: 1094-1100(1964)
8267	19-16824	J. Nucl. Energy: Pt.A and B, 19: 1-6 (1965)
8375	19-16494	Fortschr. Physik, 12: 643-66(1964)
8396	19-16828	Nucl. Sci. Eng., 21: 580-2(1965)
8404	19-15174	Radiation Botany, 5: 7-22(1965)
8409	19-16778	See BNL-8525
8445	19-16984	Phys. Rev., 137: B1455-65(1965)
8487	19-15806	Nature, 205: 537-9(1965)
8522	19-16830	Phys. Rev., 137: A1686-96(1965)
8525	19-16778	Phys. Rev., 137: A1816-21(1965)
8531	19-16572	Phys. Rev., 137: B1352-7(1965)
8538	19-16989	Phys. Rev., 137: B1491-9(1965)
8540	19-16981	Phys. Rev., 137: B1445-7(1965)
8546	19-16585	Phys. Rev., 137: B1566-72(1965)
8557	19-15523	Phys. Rev., 138: A153-5(1965)
8570	19-16988	Phys. Rev., 137: B1484-90(1965)
8601	19-15524	Phys. Rev., 138: A176-7(1965)
8622	19-16996	Phys. Rev. Letters, 14: 15-18(1965)
8687	19-16605	Phys. Rev. Letters, 14: 79-81(1965)
8715	19-17001	Phys. Rev. Letters, 14: 181-3(1965)
8717	19-16603	Phys. Rev. Letters, 14: 74-6(1965)
8722	19-16284	Phys. Rev. Letters, 14: 96-8(1965)
8751	19-17003	Phys. Rev. Letters, 14: 196-7(1965)
8812	19-15823	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8817	19-15854	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8819	19-17404	Dep.(mn); $2.00(cy), 1(mn) CFSTI
8888	19-16252	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CAR–		
882-7	19-16599	Phys. Rev. Letters, 14: 33-5(1965)
CEA-R–	(French)	
2278	19-16815	Dep.(mn)
2446	19-16062	Dep.(mn)
2457	19-15855	Dep.(mn)
2466	19-17267	Dep.(mn)
2555	19-17214	Dep.(mn)
2558	19-15780	Dep.(mn)
2577	19-15992	Dep.(mn)
2584	19-16063	Dep.(mn)
2585	19-14955	Dep.(mn)
2600	19-16013	Dep.(mn)
2607	19-15665	Dep.(mn)
2615	19-17254	Dep.(mn)
2618	19-16027	Dep.(mn)
2632	19-15713	Dep.(mn)
2634	19-16028	Dep.(mn)
CEA-tr–	(French)	
A-1597	19-15352	Dep.(mn); $1.10(fs), $0.80(mf) JCL
A-1706	19-15353	Dep.(mn); $1.10(fs), $0.80(mf) JCL
X-552	19-17367	Dep.(mn); $10.10(fs), $4.10(mf) JCL
CISE-R–	(Italian)	
93	19-15716	See EURAEC-1087
99	19-15715	See EURAEC-1085
CONF-13–	(American Physical Society 1963 Southwestern Meeting, Houston, Tex., Feb. 1963)	
14	19-17069	ORINS. Gmelin, AED-CONF-63-013-30
CONF-217–	(Radiation Research Society 11th Annual Meeting, Milwaukee, May 1963)	
5	19-15216	ORINS
CONF-263	19-17195	(International Atomic Energy Agency Symposium on Physics and Material Problems of Reactor Control Rods, Vienna, Nov. 1963) Proceedings. See STI/PUB/81.
CONF-446–	(American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964)	
81	19-16014	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-448–	(IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, Ger., May 1964)	
35	19-15343	See DPSPU-63-30-37
CONF-452–	(American Physical Society, Washington, D. C., Apr. 1964)	
74	19-16417	ORINS. Gmelin, AED-CONF-64-044-116
CONF-496–	(American Industrial Hygiene Association Meeting, Philadelphia, Apr. 1964)	
1	19-15785	See LADC-5923

Report No.	Abstract No.	Availability
CONF-501–		(Western Electric Show and Conference and IEE Summer General Meeting, Los Angeles, Aug. 1964)
2	19-15848	ORINS. Gmelin, AED-CONF-64-172-1
CONF-524–		(American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964)
17	19-16204	ORINS. Gmelin, AED-CONF-64-006-26
18	19-16071	See GE-TM-64-2-8
CONF-538	19-16454	(23rd Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 1963)
CONF-551–		(Technical Meeting on the Use of Induced Mutations in Plant Breeding Programs, Rome, May-June 1964)
3	19-15013	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-571–		(American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964)
30	19-15552	ORINS. Gmelin, AED-CONF-64-155-34
31	19-15645	ORINS. Gmelin, AED-CONF-64-155-37
33	19-15998	See LA-3118
CONF-617–		(Special Technical Conference on Nuclear Radiation Effects, Seattle, Wash., July 1964)
17	19-15938	ORINS. Gmelin, AED-CONF-64-116-32
18	19-15937	ORINS. Gmelin, AED-CONF-64-116-31
CONF-642–		(Health Physics Society, Cincinnati, June 1964)
18	19-15706	ORINS. Gmelin, AED-CONF-64-082-22
23	19-15856	See DPSPU-64-30-3
CONF-650–		(Linear Accelerator Conference, Madison, Wis., July 1964)
13	19-16325	ORINS. Gmelin, AED-CONF-64-143-10
CONF-651–		(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)
43	19-16064	Dep.(mn); $1.00(cy), 1(mn) CFSTI
46	19-16800	ORINS. Gmelin, AED-CONF-64-140-93
47	19-16802	ORINS. Gmelin, AED-CONF-64-140-94
50	19-16198	ORINS. Gmelin, AED-CONF-64-140-97
51	19-16813	ORINS. Gmelin, AED-CONF-64-140-103
52	19-16191	ORINS. Gmelin, AED-CONF-64-140-104
53	19-16190	ORINS. Gmelin, AED-CONF-64-140-105
54	19-16365	ORINS. Gmelin, AED-CONF-64-190-4
55	19-16242	ORINS. Gmelin, AED-CONF-64-190-2
59	19-16810	ORINS. Gmelin, AED-CONF-64-140-66
60	19-16809	ORINS. Gmelin, AED-CONF-64-140-65
61	19-16811	ORINS. Gmelin, AED-CONF-64-140-47
62	19-16812	ORINS. Gmelin, AED-CONF-64-140-85
64	19-16801	ORINS. Gmelin, AED-CONF-64-140-88
65	19-16808	ORINS. Gmelin, AED-CONF-64-140-89
66	19-16807	ORINS. Gmelin, AED-CONF-64-140-90
70	19-16803	ORINS. Gmelin, AED-CONF-64-140-83
81	19-16806	ORINS
83	19-17405	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-654–		(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964)
33	19-16218	See HW-SA-3626
37	19-15643	ORINS. Gmelin, AED-CONF-64-219-7
38	19-17171	ORINS. Gmelin, AED-CONF-64-219-6
41	19-17269	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-219-18
49	19-16023	ORINS. Gmelin, AED-CONF-64-219-12
CONF-669–		(Conference on Particle Physics, Boulder, Colo., June-July 1964)
4	19-16482	See UCRL-11849
CONF-691–		(Conference on Fusion of Body-Centered Cubic-Materials, Gatlinburg, Tenn., Sept. 1964)
6	19-16201	ORINS. Gmelin, AED-CONF-64-154-11
9	19-16200	ORINS. Gmelin, AED-CONF-64-154-5
CONF-695–		(EIVR-10 Atomic Weapons Research Establishment Meeting, Aldermaston, Berks, Eng., Oct. 1964)
3	19-17426	See SC-R-65-851
CONF-704–		(Proceedings of Fall Metallurgy, Paris, Oct. 1963)
2	19-16067	See EUR-1846.f
CONF-717–		(CNRS Meeting on Graft of Allogenic Hematopoietic Cells, Paris, Sept. 7–9, 1964)
17	19-15217	ORINS
18	19-15218	ORINS
CONF-718–		(American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 21, 1964)
6	19-15693	ORINS. Gmelin, AED-CONF-64-163-1
CONF-720–		(2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Oct. 1964)
6	19-16856	See ORNL-P-788
7	19-17161	See ORNL-P-786
8	19-15018	See ORNL-P-758
9	19-17162	See ORNL-P-801
11	19-16762	ORINS. Gmelin, AED-CONF-64-190-6
14	19-17173	ORINS. Gmelin, AED-CONF-64-190-21
18	19-17172	ORINS. Gmelin, AED-CONF-64-190-15
20	19-15215	ORINS. Gmelin, AED-CONF-64-190-25
29	19-16763	ORINS. Gmelin, AED-CONF-64-190-8
CONF-721–		(8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 6–8, 1964)
8	19-15404	ORINS. Gmelin, AED-CONF-64-189-5
10	19-15407	ORINS. Gmelin, AED-CONF-64-189-3
12	19-15406	ORINS. Gmelin, AED-CONF-64-189-1
CONF-729–		(International Conference on Beryllium, Philadelphia, Oct. 1964)
5	19-16192	ORINS
7	19-16193	ORINS
8	19-16194	ORINS
9	19-16046	ORINS
10	19-16045	ORINS
CONF-752	19-16294	(22nd Meeting of the Supersonic Tunnel Assoc. at the von Karman Institute for Fluid Dynamics, Rhode-Saint-Genese, Belgium, Sept. 24–25, 1964) Proceedings
CONF-763–		(American Society of Mechanical Engineers Winter Meeting, New York, Nov. 29–Dec. 4, 1964)
9	19-17328	ORINS
34	19-17329	ORINS
35	19-17188	ORINS
38	19-17334	ORINS
CONF-769–		(Conference on Electrical Insulation, Cleveland, Oct. 11–14, 1964)
8	19-16243	ORINS. Gmelin, AED-CONF-64-199-1
CONF-773–		(Symposium on Chemical Effects Associated With Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964)
23	19-15644	ORINS
34	19-15647	ORINS
CONF-776–		(National Electronics Conference, Chicago, Oct. 1964)
7	19-15939	ORINS
CONF-778–		(Metals/Materials Congress, Philadelphia, Oct. 1964)
6	19-15729	ORINS. Gmelin, AED-CONF-64-201-8
CONF-783–		(Norwegian Physical Society Annual Meeting, Bergen, Norway, June 6–8, 1963)
1	19-17152	ORINS
CONF-787–		(5th International Conference on Nuclear Photography, Geneva, Sept. 15–18, 1964)
3	19-15859	See JINR-E-1866
4	19-16858	See UCRL-11535
CONF-789–		(American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 13–16, 1964)
3	19-17427	See SC-TM-8-62(51)
CONF-792–		(American Ceramic Society Meeting, San Francisco,

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	Oct. 28–30, 1964)	
2	19-16244	ORINS. Gmelin, AED-CONF-64-222-3
CONF-808–	(American Industrial Hygiene Assocn. Rocky Mountain Section Meeting, Colorado Springs, Oct. 29–31, 1964)	
2	19-15351	See SC-DC-64-1829
CONF-812–	(Society for Applied Spectroscopy 3rd National Meeting, Cleveland, Sept. 28–Oct. 2, 1964)	
2	19-15405	ORINS. Gmelin, AED-CONF-64-207-1
CONF-620001	19-16296	(Proceedings of the Symposium on Electron and Vacuum Physics, Budapest, 1962)
CONF-620401–	(4th Inter-American Symposium on the Peaceful Application of Nuclear Energy, Mexico City, Mex., Apr. 1962)	
1	19-16841	See IEA-75
CONF-620702	19-16185	(International Symposium on Metallic Solid Solutions, Orsay, France, June 1962)
CONF-630404–	(3rd Annual Quality Control Conference, Toledo, Ohio, Apr. 6, 1963)	
1	19-17391	See BDX-613-39
CONF-630601	19-17412	(Symposium on Research at Mound Lab., Miamisburg, Ohio, June 6–7, 1963)
CONF-631104–	(Meeting on the Utilization of Research Reactors, Sao Paulo, Brazil, Nov. 4–8, 1963)	
1	19-17386	ORINS
CONF-631106–	(Seminar on Zirconium Alloys, Wallingford, Conn., Nov. 13, 1963)	
1	19-17264	See AD-422953
CONF-631107–	(4th National Vacuum Symposium, Kyoto, Japan, Nov. 21–22, 1963)	
1	19-16003	See UCRL-7562
CONF-631108–	(IEEE Symposium on Measurements and Instrumentation, Kansas City, Mo., Nov. 21, 1963)	
1	19-17392	See BDX-613-43
CONF-640202	19-16300 19-17025	(8th Annual Symposium on Nuclear Physics and Solid State Physics, Chandigarh, India, Feb. 24–28, 1964)
CONF-640203	19-16668	(Conference on Weak Interactions and Higher Symmetries, Schladming, Austria, Feb. 24–Mar. 7, 1964)
CONF-640205	19-16885	(14th Annual Conference on Nuclear Spectroscopy, Tbilisi, USSR, Feb. 14–22, 1964)
CONF-640401–	(Tenth Metallography Colloquium, St. Christoph am Arlberg, Germany, Apr. 16, 1964)	
1	19-16302	See SGAE-G-2/1964
CONF-640403–	(5th Symposium on the Engineering Aspects of Magnetohydrodynamics, Cambridge, Mass., Apr. 1–2, 1964)	
1	19-16459	ORINS. Gmelin, AED-CONF-64-036-11
CONF-640404–	(Joint Working Group Weapons Research Development Meeting, Aldermaston, Reading, Berkshire, England, Apr. 27–29, 1964)	
1	19-16080	See UCRL-7767
CONF-640405–	(Panel Meeting of the German Atom Forums on Reactor Theory, Karlsruhe, Germany, Apr. 22–24, 1964)	
1	19-17215	See EUR-2105.e
CONF-640504–	(American Society of Mechanical Engineers, Fluids Engineering Conference, Philadelphia, May 18–20, 1964)	
1	19-17209	ORINS. Gmelin, AED-CONF-64-165-1
CONF-640505–	(Society of Plastics Engineers, Milwaukee, Wis., May 18, 1964)	
1	19-17393	See BDX-613-56
CONF-640603–	(Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio, June 15–19, 1964)	
3	19-16663	ORINS. Gmelin, AED-CONF-64-117-5
CONF-640606–	(American Physical Society Summer Meeting, Denver, Colo., June 25–27, 1964)	
11	19-16436	ORINS. Gmelin, AED-CONF-64-113-39
12	19-16664	ORINS. Gmelin, AED-CONF-64-113-34
13	19-16418	ORINS. Gmelin, AED-CONF-64-113-4
16	19-17068	ORINS. Gmelin, AED-CONF-64-113-9
17	19-17143	ORINS. Gmelin, AED-CONF-64-113-24
CONF-640610–	(Conference on Precision Electromagnetic Measurements, Boulder, Colo., June 23–25, 1964)	
1	19-16299	ORINS. Gmelin, AED-CONF-64-102-2
CONF-640611–	(Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Canada, June 11–13, 1964)	
1	19-15328	ORINS. Gmelin, AED-CONF-64-108-7
6	19-15932	ORINS. Gmelin, AED-CONF-64-108-6
7	19-15329	ORINS. Gmelin, AED-CONF-64-108-5
CONF-640612–	(15th Annual Mid-America Symposium on Spectroscopy, Chicago, June 2–5, 1964)	
1	19-16205	ORINS. Gmelin, AED-CONF-64-080-6
CONF-640701–	(International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris, July 6–11, 1964)	
11	19-16195	ORINS
12	19-16196	ORINS
13	19-16460	ORINS
14	19-16197	ORINS
15	19-16461	ORINS
16	19-16462	ORINS
27	19-17144	ORINS
CONF-640803–	(Conference on the Physics of Type II Superconductivity, Cleveland, Aug. 28–29, 1964)	
1	19-16804	ORINS. Gmelin, AED-CONF-64-141-1
2	19-16805	ORINS. Gmelin, AED-CONF-64-141-2
CONF-640805–	(International Society of Hematology Congress, Stockholm, Aug. 30–Sept. 4, 1964)	
1	19-17404	See BNL-8819
CONF-640807–	(3rd International Meeting on Diseases of Cattle, Copenhagen, Aug. 20–22, 1964)	
1	19-17406	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-640902–	(3rd International Measurement Conference, Stockholm, Sept. 14–19, 1964)	
2	19-15877	Acta IMEKO (Intern. Messtech. Konf.), 1964, 493-508
7	19-15850	Acta IMEKO (Intern. Messtech. Konf.), 1964, 475-92
CONF-640903–	(American Vacuum Society Symposium, Chicago, Sept. 30–Oct. 2, 1964)	
4	19-15741	ORINS. Gmelin, AED-CONF-64-171-36
6	19-15743	ORINS. Gmelin, AED-CONF-64-171-15
8	19-16324	ORINS. Gmelin, AED-CONF-64-171-13
9	19-15742	ORINS. Gmelin, AED-CONF-64-171-10
10	19-15744	ORINS. Gmelin, AED-CONF-64-171-34
CONF-640906–	(Symposium on Evolving Genes and Proteins, New Brunswick, N. J., Sept. 1964)	
1	19-17434	See UCRL-11683
CONF-640909–	(International Conference on Radiation Preservation of Foods, Boston, Sept. 27–30, 1964)	
10	19-15943	Dep.(mn); $2.00(cy), 1(mn) CFSTI; ORINS. Gmelin, AED-CONF-64-168-4
CONF-640913–	(Faraday Society Dislocation in Solids Meeting, Gottingen, Germany, Sept. 15–17, 1964)	

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1	19-16070	See EURAEC-1075
CONF-641002–		(Summaries of Fourth Annual AEC Food Irradiation Contractors Meeting, Washington, D. C., Oct. 21–22, 1964)
	19-15944	Dep.; $6.00(cy), 4(mn) CFSTI
CONF-641008–		(Seminar on Plasma Physics, Trieste, Italy, Oct. 5–31, 1964)
1	19-17145	ORINS
CONF-641009–		(Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y., Oct. 5–7, 1964)
3	19-15941	ORINS. Gmelin, AED-CONF-64-193-10
4	19-16833	ORINS. Gmelin, AED-CONF-64-193-2
5	19-15646	ORINS. Gmelin, AED-CONF-64-193-4
7	19-15940	ORINS. Gmelin, AED-CONF-64-193-8
8	19-15707	ORINS. Gmelin, AED-CONF-64-193-7
CONF-641014–		(2nd Annual Conference on Energy Conversion and Storage, Stillwater, Okla., Oct. 12–13, 1964)
1	19-16464	ORINS. Gmelin, AED-CONF-64-206-1
CONF-641016–		(17th Annual Gaseous Electronics Conference, Atlantic City, Oct. 14–16, 1964)
1	19-16419	ORINS. Gmelin, AED-CONF-64-223-1
CONF-641017–		(Symposium on Low Energy X and Gamma Sources and Applications, Chicago, Oct. 20–21, 1964)
1	19-15849	ORINS. Gmelin, AED-CONF-64-221-2
CONF-641018–		(The Electrochemical Society, 126th Meeting, Washington, D. C., Oct. 11–15, 1964)
1	19-16203	ORINS. Gmelin, AED-CONF-64-205-4
3	19-15349	See NLCO-929
CONF-641019–		(Japanese Biochemical Society Meeting, Nagoya, Japan, Oct. 1964)
1	19-14956	See NYO-901-3
CONF-641105–		(Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology, Prague, Nov. 23–27, 1964)
2	19-15007	ORINS
3	19-15008	ORINS
CONF-641108–		(American Physical Society, New York, Nov. 4–8, 1964)
4	19-17146	ORINS. Gmelin, AED-CONF-64-196-6
5	19-17147	ORINS. Gmelin, AED-CONF-64-196-15
6	19-17148	ORINS. Gmelin, AED-CONF-64-196-14
7	19-16463	ORINS. Gmelin, AED-CONF-64-196-13
8	19-17149	ORINS. Gmelin, AED-CONF-64-196-11
9	19-17150	ORINS. Gmelin, AED-CONF-64-196-9
CONF-641112	19-17327	(Atomic Industrial Forum, 1964 Annual Conference, San Francisco, Nov. 30–Dec. 3, 1964)
CONF-641116–		(Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C., Nov. 16–18, 1964)
1	19-16199	ORINS. Gmelin, AED-CONF-64-224-1
CONF-641117–		(19th High Temperature Fuels Committee Meeting, Thousand Oaks, Calif., Nov. 16–18, 1964)
1	19-16219	See LA-DC-6753
CONF-641201–		(American Institute of Chemical Engineers Annual Meeting, Boston, Dec. 6–10, 1964)
6	19-17151	ORINS
14	19-15790	See SC-R-64-1366
CONF-641208–		(3rd Conference on Performance of High Temperature Systems, Pasadena, Calif., Dec. 1964)
2	19-16202	ORINS
CONF-641209–		(International Summer School of Physics Course on Automata Theory, Ravello, Italy, Dec. 1964)
1	19-15980	See EUR-2186.e
CONF-650103–		(International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex., Jan. 11, 1965)
2	19-15697	See ORNL-P-869
3	19-15942	See ORNL-P-920
CONF-650107–		(Royal Society Meeting on Seismic Recording and Analysis, London, Jan. 28–29, 1965)
1	19-15767	See UCRL-12219
CONF-650202–		(American Crystallographic Assn., Suffern, N. Y., Feb. 22–26, 1965)
1	19-17418	See ORNL-P-815
CONF-650203–		(National American Institute of Mechanical Engineers Meeting, Chicago, Feb. 14–18, 1965)
1	19-15997	See K-L-6020
CONF-650204–		(Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C., Feb. 24–26, 1965)
1	19-15823	See BNL-8812
CONF-650206	19-17332	(Water Desalination Information Meeting, Oak Ridge, Tenn., Feb. 23–24, 1965)
CONF-650210–		(Application of X-Ray Diffraction in the Atomic Energy Field Meeting, Richland, Wash., Feb. 23–24, 1965)
1	19-16065	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2	19-16066	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-650301–		(Symposium on the Physics and Chemistry of Fission, Salzburg, Mar. 22–26, 1965)
3	19-16846	See LA-DC-6666
CONF-650305–		(Conference on Physics and Chemistry of Fission, Vienna, Mar. 22, 1965)
1	19-16848	See MIT-905-30
CONF-650403–		(International Conference on Non-Linear Magnetics, Washington, D. C., Apr. 21–23, 1965)
1	19-15982	See SC-DC-65-1132
CONF-650404–		(National Telemetering Conference, Houston, Apr. 15, 1965)
1	19-15876	See UCRL-12401-T
CONF-650405–		(International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19–22, 1965)
1	19-15346	See IS-1105
CONF-650406–		(Symposium on Neutron Dynamics and Control, Tucson, Ariz., Apr. 5–7, 1965)
1	19-17282	See WCAP-5496
COO–		
264-223	19-16582	Phys. Rev., 137: B1553-5(1965)
264-227	19-16786	Phys. Rev. Letters, 14: 98-102(1965)
427-44	19-15979	Dep.(mn); $3.00(cy), 2(mn) CFSTI
716-9	19-15502	J. Inorg. Nucl. Chem., 27: 293-6(1965)
881-42	19-16611	Phys. Rev. Letters, 14: 118-21(1965)
1024-12	19-15157	Radiation Botany, 4: 347-53(1964)
1097-12	19-14975	Crop Sci., 4: 586-9(1964)
1148-93	19-15341	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1148-94	19-17407	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1197-9	19-17408	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1197-10	19-17409	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1197-12	19-15409	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1198-207	19-15516	Phys. Rev., 137: A1449-54(1965)
CVNA–	(Misc.)	
227	19-17270	Dep.(mn); $3.00(cy), 2(mn) CFSTI
D–	(Misc.)	
2-90570	19-15941	See CONF-641009-3
DCBRL–	(Canadian)	
443	19-15063	Can. J. Biochem., 43: 119-22(1965)
DCI–	(Canadian)	

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52	19-15342	Dep.; $0.50(AECL)
DLCS–		
3430106	19-17271	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5001164	19-17272	Dep.(mn); $2.00(cy), 1(mn) CFSTI
DMIC–	**(Non-AEC)**	
209	19-16029	
DP–		
419	19-15695	Dep.(mn); $2.00(cy), 1(mn) CFSTI
714	19-15666	Dep.(mn); $1.00(cy), 1(mn) CFSTI
752	19-15667	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DPSPU–		
63-30-37	19-15343	Dep.(mn); $1.00(cy), 1(mn) CFSTI
64-30-3	19-15856	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DPST–		
64-83-12	19-17273	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EE–	**(Misc.)**	
28	19-16263	See USCEC-82-212
30	19-15701	See USCEC-82-214
EFINS–	**(Misc.)**	
64-58	19-16582	See COO-264-223
EUR–	**(European Atomic Energy Community)**	
1356.e	19-15233	Transplantation, 2: 393-404(1964)
1751.e	19-16070	See EURAEC-1075
1846.f	19-16067	Dep.(mn)
1894.i	19-16068	Dep.(mn)
2105.e	19-17215	Dep.(mn)
2113.f	19-15781	Dep.(mn)
2147.d	19-14967	Atomkernenergie, 9: 283-93(1964)
2186.e	19-15980	Dep.(mn)
2187.e	19-16816	
2189.f	19-15410	Dep.(mn)
2197.d	19-17156	Dep.(mn)
2205.f	19-16069	Dep.(mn)
2207.i	19-15344	Dep.(mn)
2211.d	19-15714	Dep.(mn)
2213.e	19-15782	Dep.(mn)
2217.e	19-17216	Dep.(mn)
EURAEC–		
1075	19-16070	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1085	19-15715	Dep.(mn); $4.00(cy), 4(mn) CFSTI
1087	19-15716	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1199(Suppl.)	19-17255	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1249	19-16208	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1250	19-17274	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1272	19-17275	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1313	19-17276	See GEAP-4702
1322	19-16015	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1328	19-16838	See BAW-3125-3
1329	19-15718	See NYO-3114-5
FG-E–	**(Non-AEC)**	
5.11	19-15751	See NP-14776
FTD-TT–	**(Non-AEC)**	
64-442	19-15702	CFSTI
64-644	19-15023	$1.00(CFSTI)
GA–	**(Misc.)**	
5554	19-16817	Dep.; $4.00(cy), 3(mn) CFSTI
5640	19-15993	$2.00(CFSTI)
5652	19-16367	
5884	19-16839	
GAT–		
450	19-15783	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GE-TM–		
64-2-8	19-16071	Dep.(mn); $1.00(cy), 1(mn) CFSTI

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GEAP–	**(Misc.)**	
3455	19-17338	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3583	19-17339	Dep.(mn); $4.00(cy), 2(mn) CFSTI
4702	19-17276	Dep.(mn); $5.00(cy), 3(mn) CFSTI
4747	19-15857	Dep.(mn); $2.00(cy), 1(mn) CFSTI
GNE-Phys–	**(Non-AEC)**	
64-3	19-17360	$5.00(CFSTI)
GSP–	**(Non-AEC)**	
64	19-16728	See AD-603599
GSP-Phys–	**(Non-AEC)**	
64-3	19-17070	See AD-603685
64-15	19-16248	See AD-603602
HPR–	**(Norwegian)**	
43	19-17189	Dep.(mn)
HW–		
61794	19-17335	$1.00(cy), 1(mn) CFSTI
83181	19-15668	Dep.(mn); $1.00(cy), 1(mn) CFSTI
83603	19-16437	Dep.; $2.00(cy), 1(mn) CFSTI
83614	19-15784	Dep.; $2.00(cy), 1(mn) CFSTI
83716	19-17336	$4.00(cy), 2(mn) CFSTI
84281	19-15994	Dep.; $4.00(cy), 3(mn) CFSTI
84467	19-17388	Dep.; $2.00(cy), 1(mn) CFSTI
HW-SA–		
3089	19-17204	See p.591-616 of STI/PUB/81
3320	19-16253	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3359	19-17410	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3379	19-15727	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3445	19-14963	Am. Rev. Respirat. Diseases, 90: 963-7(1964)
3626	19-16218	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3726	19-15897	Nucl. Instr. Methods, 33: 71-6(1965)
IAEA–	**(International Atomic Energy Agency)**	
2616	19-17411	Dep.(mn); $1.00(cy), 1(mn) CFSTI
IDO–		
11401	19-15553	Dep.; $7.80(cy), 9(mn) CFSTI
17028	19-17217	Dep.; $6.00(cy), 5(mn) CFSTI
17038	19-17340	Dep.; $3.00(cy), 2(mn) CFSTI
17050	19-16840	Dep.; $3.00(cy), 2(mn) CFSTI
IEA–	**(Brazilian)**	
75	19-16841	Dep.(mn)
IFA-MC–	**(Rumanian)**	
7	19-16842	Dep.(mn)
IITRI–	**(Misc.)**	
578P24-12	19-16843	Dep.; $4.00(cy), 3(mn) CFSTI
B231-11	19-15995	
B6019-4	19-15996	$1.00(CFSTI)
IPP–	**(Non-AEC)**	
6	19-17073	Dep.(mn)
9	19-17074	Dep.(mn)
IPR–	**(Brazilian)**	
44	19-17386	See CONF-631104-1
IS–		
961	19-15397	Spectrochim. Acta, 21: 289-93(1965)
1002	19-16976	Phys. Rev., 137: A1828-34(1965)
1105	19-15346	Dep.(mn); $1.00(cy), 1(mn) CFSTI
ISS–	**(Italian)**	
64/36	19-16844	Dep.(mn)
JAERI–	**(Japanese)**	
1087	19-17367	For translation see CEA-tr-X-552
JINR–	**(Russian)**	
D-1929	19-16665	Dep.(mn)
E-1866	19-15859	Dep.(mn)
E-1898	19-16467	Dep.(mn)

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E-1921	19-15669	Dep.(mn)
E-1930	19-15411	Dep.(mn)
P-1911	19-16368	Dep.(mn)
P-1918	19-16468	Dep.(mn)
P-1919	19-16469	Dep.(mn)
P-1920	19-16470	Dep.(mn)
P-1927	19-16471	Dep.(mn)
P-1928	19-16666	Dep.(mn)
P-1933	19-16472	Dep.(mn)
P-1939	19-16473	Dep.(mn)
K-L–		
6018	19-15696	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6020	19-15997	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6021	19-15860	Dep.(mn); $2.00(cy), 1(mn) CFSTI
KAPL-M–		
6162	19-17218	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KFK–	(German)	
225	19-15412	
233	19-15670	Dep.(mn)
246	19-15413	
L–	(Misc.)	
0774-01-9(Vol.II)	19-17346	See NASA-CR-59366
LA–		
3116	19-17362	Dep.; $3.00(cy), 2(mn) CFSTI
3118	19-15998	Dep.; $2.00(cy), 1(mn) CFSTI
3169	19-16845	Dep.; $2.00(cy), 1(mn) CFSTI
3199	19-15825	Dep.; $2.00(cy), 1(mn) CFSTI
LA-DC–		
6510	19-16351	Phys. Rev., 137: B1644-?(1965)
6522	19-16826	Nucl. Sci. Eng., 21: 498-508(1965)
6547	19-17120	Rev. Sci. Instr., 36: 395-6(1965)
6610	19-16987	Phys. Rev., 137: B1479-84(1965)
6641	19-16043	Trans. Met. Soc. AIME, 233: 437-8(1965)
6666	19-16846	$1.00(cy), 1(mn) CFSTI
6753	19-16219	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LA-tr–		
65-2	19-15466	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL
65-3	19-15467	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL
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5923	19-15785	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6291	19-16474	Dep.(mn); $2.00(cy), 1(mn) CFSTI
LAL–	(French)	
1069	19-16847	
1109	19-16475	Dep.(mn)
1123	19-16301	Dep.(mn)
MATT–		
221	19-16254	Dep.(mn); $1.00(cy), 1(mn) CFSTI
253	19-17102	J. Math. Phys. (N. Y.), 6: 327-35(1965)
272	19-17097	J. Appl. Phys., 36: 675-8(1965)
MHD–	(Non-AEC)	
666	19-16446	
MIT–	(Misc.)	
905-30	19-16848	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2098-68	19-16643	Rev. Sci. Instr., 36: 283-8(1965)
2098-62	19-17010	Rev. Mod. Phys., 36: 1076-8(1964)
2098-108	19-16353	Phys. Rev. Letters, 14: 91-4(1965)
ML–	(Misc.)	
1146	19-16255	$5.00(CFSTI)
ML-TDR–	(Non-AEC)	
64-277	19-15999	
MLM–		
1163	19-17412	Dep.; $5.00(cy), 3(mn) CFSTI
1230J	19-15360	Anal. Chem., 37: 414(1965)
MSAR–	(Misc.)	
64-108	19-15407	See CONF-721-10
N–	(Misc.)	
64-29573	19-15015	$2.00(CFSTI)
64-33917	19-17346	See NASA-CR-59366
65-15591	19-15993	See GA-5640
NAA-SR–		
8277	19-15570	Dep.; $0.50(cy), 1(mn) CFSTI
10496	19-17341	Dep.; $2.00(cy), 1(mn) CFSTI
10531	19-17279	Dep.; $3.00(cy), 2(mn) CFSTI
NAA-SR-Memo–		
8339	19-17342	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8889	19-16850	Dep.(mn); $2.00(cy), 2(mn) CFSTI
10293	19-17343	Dep.(mn); $3.00(cy), 3(mn) CFSTI
10544	19-16851	Dep.(mn); $2.00(cy), 2(mn) CFSTI
10632	19-17219	Dep.(mn); $3.00(cy), 2(mn) CFSTI
10660	19-17344	Dep.(mn); $1.00(cy), 1(mn) CFSTI
10667	19-17345	Dep.(mn); $2.00(cy), 1(mn) CFSTI
10922	19-17190	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NASA-CR–	(Misc.)	
164	19-15717	$1.00(CFSTI)
54227	19-16367	See GA-5652
54260	19-16839	See GA-5884
54266	19-15993	See GA-5640
59366	19-17346	$4.00(CFSTI)
NASA-TN–	(Misc.)	
D-2649	19-16076	$1.00(CFSTI)
D-2651	19-16447	$2.00(CFSTI)
D-2712	19-17347	$1.00(CFSTI)
NDL-TR–	(Non-AEC)	
46	19-15861	
NLCO–		
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14408	19-15016	Dep.(mn)
14629	19-15862	Dep.(mn)
14647	19-16852	Dep.(mn)
14649	19-15863	Dep.(mn)
14680	19-16476	Dep.(mn)
14684	19-17413	
14687	19-16853	Dep.(mn)
14690	19-15864	Dep.(mn)
14692	19-15865	Dep.(mn)
14698	19-15648	Dep.(mn)
14699	19-15866	Dep.(mn)
14700	19-15649	Dep.(mn)
14701	19-15867	Dep.(mn)
14702	19-16369	Dep.(mn)
14703	19-17280	Dep.(mn)
14704	19-15868	Dep.(mn)
14715	19-15869	Dep.(mn)
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14732	19-15871	Dep.(mn)
14773	19-15787	
14776	19-15751	
14778(Pt.I)	19-15752	
14778(Pt.II)	19-15753	
14781	19-15754	Dep.(mn)
14792	19-16854	
14795	19-17348	
14797	19-15755	Dep.(mn)
14805	19-15219	
14814	19-15756	$1.50(CFSTI)
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14835	19-15788	
14850	19-16478	Dep.(mn)
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NUMEC–		
3432-6	19-16220	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NYO–		
98-3	19-17414	Dep.(mn); $3.00(cy), 2(mn) CFSTI
98-4	19-17415	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NYO–		
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